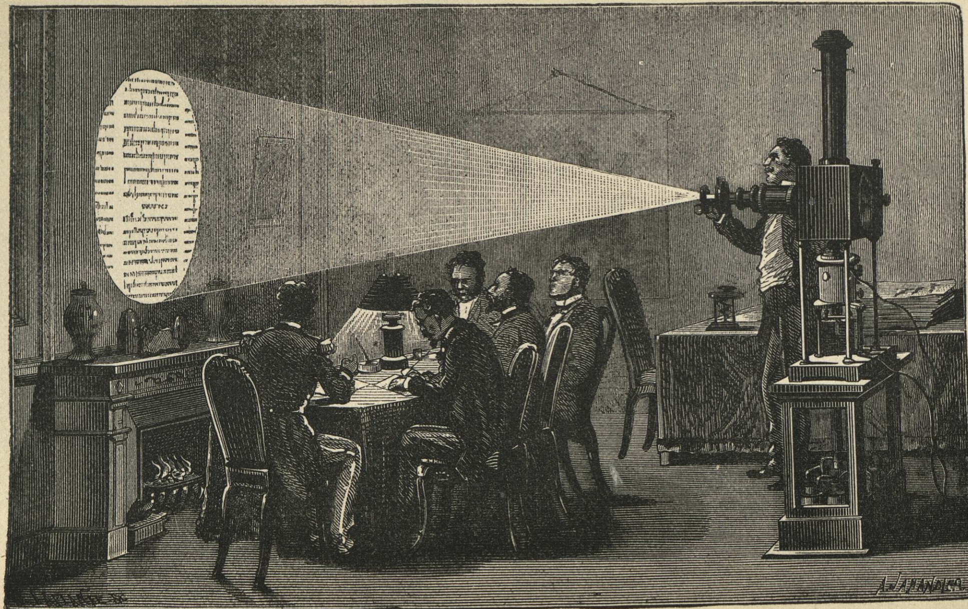


The Microscope Lantern.—p. 118.

Frontispiece.

65. 1

THE MAGIC LANTERN MANUAL.

BY

W. J. CHADWICK.

WITH

ONE HUNDRED PRACTICAL ILLUSTRATIONS.

London:
FREDERICK WARNE AND CO.,
BEDFORD STREET STRAND.

DALZIEL BROTHERS
Camden Press
ENGRAVERS & PRINTERS

PREFACE.

THE writer hopes to be acquitted of presuming to teach many new things to his brother Lanternists by this little treatise; he is actuated rather by other motives in giving a few practical explanations and descriptions of the various forms of Magic Lanterns, with their details and application; and although forming a book of instruction to the learner, he trusts it will take its place as a handbook to the expert Lanternist.

If the writer has failed to navigate his little ship quite clear of the stream of all commercial interests, he trusts the apology will be thought sufficient, that he considers it is in all cases quite as important to know *where* to purchase as it is to know *what* to purchase.

And he feels happy in the opportunity which this publication affords him of acknowledging the obligations he is under to a few commercial firms and personal friends for the use of many valuable illustrations and suggestions, which have assisted him in launching his frail craft on the wide seas of criticism. He has now only to hope for a kindly reception, and he is fully rewarded.

W. J. CHADWICK.

Alexandra Park, Manchester,
30th October, 1878.

CONTENTS.

	Page
Introduction	9
The Magic Lantern	12
Condensers	13
Objectives	17
The Sciopticon	20
The Pyro-Hydrogen Light	24
The Magnesium Lantern	26
The Lime Light	27
Photometry	59
Dissolving Views	61
Dancer's Lantern	67
The Malden Bi-unial Lantern	69
Chadwick's Lantern	72
Beechey's Lantern	74
Keevil's Lantern	76
The Opaque Lantern	77
Stand for the Lantern	79
Screens	81
Lantern Slides	82
Production of Photographic Slides	85
Carbon Transparencies	91
Mounting of Transparencies	94
Registering Carrier	97
Statuary	100
The Colouring of Slides	102
Effect Slides	104
Mechanical Slides	107
Viewing Pictures	111
Descriptive Lectures	113
Reading Desk	114
Scientific Projections	115

THE MAGIC LANTERN MANUAL.

INTRODUCTION.

SO much has previously been said and written on the value and merits of the Magic Lantern as an instrument for instruction and amusement, that the author does not think it possible to add much interest by enlarging upon what is already known. But for the benefit of those readers who may not have studied the Magic Lantern, it may be remarked that within the last five or six years this instrument has become much more popular than for some time previous. This rekindled interest, there is little doubt, was awakened by the introduction of the "Sciopticon," a new form of lantern admirably filling up the wide gap between the old-fashioned oil-lit lantern and the more elaborate Oxy-Hydrogen instrument, about all of which something will be said by-and-bye.

Many different ways ot applying the Magic Lantern present themselves, perhaps none more pleasing than its adaptation to Dissolving Views, which were invented by Mr. Child, the method of their production being long kept a secret by him. These charming effects were then produced as now, viz., by two lanterns provided with suitable arrangements for gradually cutting off the picture of one lantern, and disclosing that of the other by alter-

nately shutting out the light from each lantern. Ever since their introduction they have formed an everlasting source of amusement and instruction, not only at the Royal Polytechnic Institution, but at many scientific institutions throughout the country. To give some idea of the public appreciation of such exhibitions when properly conducted, it may be stated that at an exhibition of photographs of statuary given in this way at the Manchester Mechanics' Institution a few years ago, over seven hundred pounds were realized in a short time.

The popularity of the instrument has increased by its use to the photographer for enlarging purposes, and in many other ways its utility, combined with photography, has of late placed it as an indispensable apparatus to the science teacher, etc.

The simplification of oxygen gas-making for the lime light lantern has also played its part by placing powerful lights into the hands of almost inexperienced persons, with whom the manufacture of oxygen gas, in the old form, was a dreaded affair, and one only to be read about. However, these fears are now of the past, and exhibitions by the oxy-hydrogen lime light may at present be conducted on from 20 to 30 feet screens with almost as little trouble and risk of accident as with the ordinary oil light. This has only to become more widely known to again multiply our lanternists, and let us hope that before long every schoolmaster and educational teacher may be possessed of one or other form of this useful instrument.

Perhaps nothing could have enlivened the spirit of lantern exhibitions so much as photography, for now we are able to procure at a cheap rate photographic slides of almost every country in the world, and these, as well as being arranged in series, can be obtained with excellent descriptive lectures accompanying the different sets.

Of late years photographic dry plates, the extreme of simplicity in preparation, have been brought to a high state of perfection, and the whole manipulation reduced to simple rules, so that every tourist may become a photographer.

Cameras and apparatus have also had the careful consideration of both home and foreign makers, the result being that cameras for pictures up to stereoscopic and cabinet size, not exceeding one pound in weight, may be carried in the pocket, with a stand for holding same in the portable form of a walking-stick, umbrella, or alpenstock. So that a tourist may set off on his travels with his photographic apparatus in his pocket, and may return with thirty or forty souvenirs of places visited without the inconvenience of extra luggage. Thus holiday rambles may be by the aid of photography illustrated and described, and continental tours be made the subject of enjoyable and everlasting reminiscences, reproduced by aid of the lantern to our friends at home with almost living majesty.

Lectures and slides upon astronomy, natural philosophy, and in fact most other branches of science and art, are to be purchased already arranged. Temperance tales, fairy tales, comic stories, and lessons for the young are obtainable (either by purchase or hire), and still our producers' lists are not complete, and a boundless ocean is open to those who are willing to embark in the buoyant ship Industry, navigated by Captain Perseverance and his honoured crew, with Fortune at the helm.

THE MAGIC LANTERN.

THE Magic Lantern of to-day is in principle the same as constructed by Kerchler about the sixteenth century, and described by him in his book "*Ars magna lucis et umbræ,*" although it would appear that Cellini must have used some such instrument a century previous to produce phantom figures in the smoke of a fire.

The principal arrangements of the instrument consist of an illuminating power (Fig. 1), with a lens called a condenser (C) placed between the light and the picture (S). In front of this latter is placed another lens, styled an objective (O). A light-tight box encloses the whole, and prevents the emission of light, except through the lenses above mentioned.

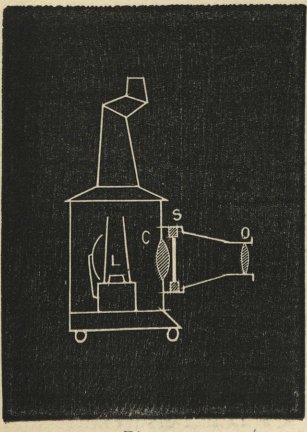


Fig. 1.

It will be perhaps as well, before entering into the illuminating powers and various forms of lanterns, to describe the optical portions of the arrangement.

OPTICAL ARRANGEMENTS.

The Condenser is for the purpose of collecting as many of the rays of light as possible, and transmitting them through the picture

on to the screen. This being understood, we will now consider the best form and size for our requirements. There are differences of opinion as to the best form of condenser for the Magic Lantern. At this there is no need for surprise, as the writer has frequently heard lanternists expressing opinions in matters concerning the optical arrangements, although possessed of but a very imperfect optical knowledge, and in some cases ignorant of the object of the various arrangements. One of the most primitive forms of condensers is the simple plano-convex lens, or common bull's-eye. This collects a certain quantity of light on the one side and distributes it on the other (the convex side); but as these "bull's-eyes" are never of short focus, they require to be farther from the light, and thus the angle of illuminating power collected is small. For it will be shown that in two condensers of unequal foci—maintaining the same diameter—the angle of light collected by each separately would differ in proportion to the square of the distance between the light and the condensers: thus, a 4-inch condenser, at 5 inches distant from the light, would only receive one-fourth the light that it would if placed $2\frac{1}{2}$ inches distant. But in shortening the focus of the condenser we are limited, by reason of its necessary additional thickness, which increases its liability to fracture, being placed nearer to the light. The shorter the focal length of the lens the thicker it must be, consequently more liable to come to grier.

Double condensers are therefore better adapted for our present requirements, for if two such lenses as above described be placed together, the focal length of the combination is reduced one-half, so that a double condenser of 3 inches focus can be made by each placing two lenses each of 6 inches focus together. As such lenses would be proportionately thinner, they are more able to withstand the heat to which they are sometimes subjected.

Different arrangements of double condensers have from time to time been tried, with the object of taking in a greater angle of light, and of being as free from spherical and chromatic aberration as possible (consistent with moderation in cost). The nearest combination of these qualities (all of which are a desideratum in a good condenser) will be found in one introduced by Sir John Herschel in the year 1821. This is generally considered to be about the best double condenser, and the one most generally adopted in good lanterns.

It consists of a meniscus and a bi-convex lens mounted together, with the concave side of the meniscus next to the light (see Fig. 2).

Fig. 2.

Fig. 3.

In purchasing, notice should be paid to this point, as the author has several times found in lanterns of a supposed first-class character that the lenses of the condensers were mounted the *wrong way*—viz., the concave side nearest the picture and the bi-convex side next the light. How this should have happened he is at a loss to conceive, unless it be that those employed in putting lanterns together either know no better or have not given the matter con-

sideration. He was much surprised a short time ago to receive from a celebrated maker a pair of condensers which were mounted the wrong way, and upon inquiring into the mistake, the reply was that the lenses were in the positions as usually supplied to the shops.

Another form of double condenser, which has been extensively used during the last few years, consists of two plano-convex lenses, mounted with their convex sides together, almost touching (Fig. 3); and although for all ordinary purposes there is no choice between this and the last described, yet this one has the advantage of being produced at a somewhat cheaper rate. As a superior condenser, the triple form carries the palm. There are many modifications of this style, the first of which the author believes was constructed by the late Andrew Ross, Esq., in 1836; but he believes the most approved one to be one recommended by Mr. J. Trail Taylor, in the "British Journal Photographic Almanac," 1877, consisting of a pair of lenses mounted similar to Herschel's arrangement, with a small plano-convex lens interposed between them and the light, as shown in Fig. 4. By this arrangement the focus is shortened, and a greater angle of light collected. The introduction of a small plano-convex lens may also be adapted to the double plano-convex form (Fig. 3), and it was by the use of this arrangement some years ago that the illuminating power of the old lanterns at the Royal Polytechnic, with large long-focus condensers, was greatly increased.

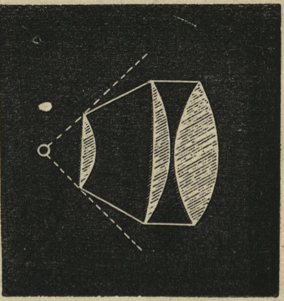


Fig. 4.

Triple condensers are often used in lanterns of American manu-

facture of the best quality, and although they do not seem to be so generally adopted in this country as they merit, the author has every confidence in recommending them to those in search of the best condensers. The size of condenser must, to some extent, be decided by the size of picture to be shown, as for small pictures it is useless to have large condensers, throwing rays of light only a portion of which are transmitted through the picture.

In the days of hand-painted slides, which were usually of large size (in some instances as much as 6 inches square or more), condensers of equal proportions were necessary to cover them; but now that photography has stepped in, we are able to produce slides of small size with much greater delicacy and finer detail than is possible for our ablest artists to produce on large size slides; consequently, having reduced the size of our pictures, we may proportionately reduce the size of our condensers.

Should the pictures be square or cushion-shaped (the case in most French slides, as well as in those of our American cousins, and also of many produced by the Woodbury process), a condenser must be used a little larger in diameter than the distance across the picture; but with slides mounted in circles (as those of Mr. York and others) smaller condensers may be used. For general purposes, the author has concluded that condensers having a diameter of $3\frac{1}{2}$ to 4 inches, and a focus of $2\frac{1}{2}$ inches, are the most useful size, the latter diameter being large enough to cover the largest photographic slides in general use.

In some double condensers each lens is made of different quality of glass, and this has misled some to suppose that they were achromatic. It is not necessary that the condensers should be perfectly achromatic, and it is preferable that all condenser lenses should be composed of the whitest flint glass.

Although a few specks, bubbles, or even a scratch or two, are

not very detrimental to a condenser's performance, such would not be offered by any optician of standing. Let care be taken that the lenses do not fit too tightly in their mounts, so as to allow for expansion by heat when in operation; they should be sufficiently slack to be turned round in their cells by the fingers.

Before using the condenser it is advisable to warm the same before the fire or otherwise, so that the sudden heat when the light is turned up may not fracture it, also to dispel any moisture that may accumulate on the lenses. An outlet for this moisture should be provided in the centre of the brass ring in which the lenses are mounted, by having a few holes drilled therein.

OBJECTIVES.

Having fully described the condenser and its functions, let us now consider the matter of the Objective Lens. Its duty is to magnify the small picture previously illuminated by aid of the condenser, and to project the same on to the screen.

The qualities desired in a Lantern Objective are equal definition at sides and centre of picture, depth of focus, freedom from distortion and from chromatism. Although it is of importance to adopt condensers of good construction and quality, it is of far greater importance that good object glasses be used; for, with a condenser of somewhat inferior quality, and a good Objective, a much better result will be obtained than could be with a good condenser and an inferior Objective. The author would not, therefore, feel justified in occupying time or attention in describing the worst of all Objectives—a single bi-convex lens, used only in inferior or toy lanterns. Better than this are two plano-convex lenses, mounted with the concave sides together, similar to the condenser (Fig. 3); but, to get anything like good definition, they must be of long focus; and in "second-rate" lanterns, this is often objected

to, they being principally used for showing comic slips, where the larger the picture the better appreciated by the juveniles. Some lanternists pride themselves upon the large size of disc they can show, and often it is required to exhibit a picture 10 feet in diameter in a distance of 10 feet; but, as short-focus lenses disperse the rays of light at greater angles, inferior definition is the result. A short-focus Objective, which has found favour with many, consists of a bi-convex and a meniscus lens mounted together: the bi-convex being nearest to the picture, and the concave side of the meniscus outside, or farthest from the picture, with a diaphragm a little distance in front of it. Although giving better definition than those previously mentioned, the small diaphragm, which is necessary to give sharpness to the picture alike at centre with edges, tends to diminish the illumination on the screen.

The Photographic Portrait Combination Lens possesses all the requirements necessary in a Lantern Objective; for while being achromatic, it has, if of moderately good quality, sufficient depth of definition and flatness of field to satisfy the most fastidious.

These lenses have received the careful consideration of many of our ablest opticians, and, by reason of their extensive manufacture, they can be procured at an exceedingly low price.

An Achromatic Portrait Combination is made by Darlot, and many English makers, of moderately short focus; and although the front lenses are of less diameter than the back combinations, the screws are made alike, so that the front lenses can be reversed, and thereby a long-focus Objective obtained, which in many instances proves a great convenience, as when working from the back of an audience in a large room.

For his own choice, the author much prefers to see a small, sharp, bright picture, than a large one of inferior definition and illumination; therefore, for this reason, would recommend the

adoption of Objectives of long foci, whenever it may be practicable.

It must be understood that the smaller the picture is shown the brighter will be the illumination, for "light decreases inversely as the square of the distance;" thus, a picture shown to 10 feet in diameter would be about twice as well illuminated as if shown 14 feet diameter, or exactly four times as well as if shown 20 feet in diameter.

Having now completed our survey, and described the optical portions of the Magic Lantern and their respective functions, let us now describe and illustrate the various illuminating powers applicable.

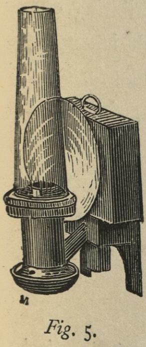


Fig. 5.

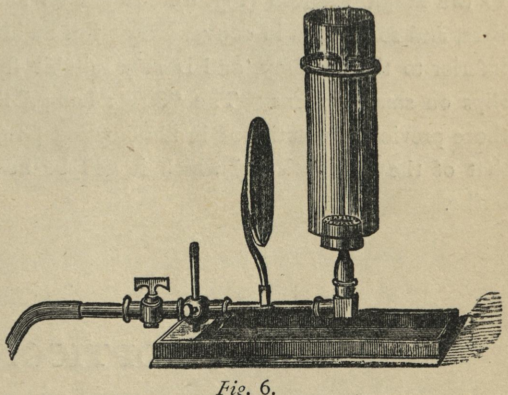


Fig. 6.

The simplest form of these is the little ordinary oil-lamp, now only used in toy lanterns, which throw a disc of 2 to 4 feet, for exhibiting comic slips.

Superior to this is the "Argand Fountain Lamp," with concave silvered reflector (shown at Fig. 5), in which circular wicks and

the best sperm or colza oil can be used, previously camphorated. It may be camphorated by adding camphor, previously pounded in a mortar, with a little alcohol, about two ounces to the pint of oil being sufficient. It has been recommended to soak the wicks in strong vinegar, and allow them to dry thoroughly before use, as a preventive against charring.

Reflectors should be of the same focal length as the condensers, the illuminating power being directly midway between the condenser and the reflector. Often no attention is paid to this matter, the result being that the reflector is worse than useless. Glass reflectors, when silvered by Liebig's process (on the surface, not behind), are much superior to metal ones. We must not omit to mention the Argand Burner, in which house gas is used as adapted to the Magic Lantern (Fig. 6). It has an advantage in cleanliness, and sometimes in convenience; but its illuminating power is inferior to the oil lamp, and is only suitable for exhibiting comic slips on small screens. The "Silber Lamp," though it surpasses those previously mentioned in illuminating power, falls far behind that of the "Sciopticon," which it will be now our duty to describe.

THE SCIOPTICON.

THE name of this Instrument is equally novel as is its whole construction, when compared with the original instrument. The name is derived from two Greek words signifying "Shadow View" or "Shadow Picture." Its inventor is Mr. L. Marcy, of Philadelphia, and it was first introduced into this country by Mr. W. B. Woodbury, who thought it a fit instrument to institute as a

medium between the old oil lantern and the expensive and elaborate oxy-hydrogen lantern.

Its chief feature is its lamp, which is arranged to use two wicks, placed edgewise to the condenser, and in which paraffin or the best crystal oil (camphorated as previously explained, but in less quantity) may be used to produce a light far surpassing anything previously seen in the form of oil lamps.

Its optical portions are of exceedingly good quality, and its

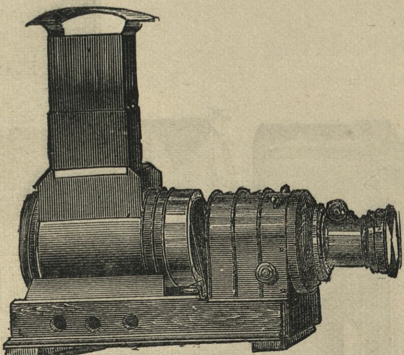


Fig. 7.

convenient and novel form, together with its lightness and portability, have secured for it an unexceptionable reputation. Fig. 7 shows an external view of the instrument, and Fig. 8 is a sectional view of the same, by which we will explain its various parts.

A B C and D are the lenses of the achromatic objective, E the milled head for focussing, F the flange of the objective, by which it is secured to the ring G, which is made of wood, for the convenience of changing the objectives for any other size or description that may be necessary in a special case. H and H′, framework carrying objective, which is made to draw in or out to suit

the focal length of the objective. L, portion of framework forming base of the instrument. M and N, claw and flange, by which the instrument is secured to the top of a neat packing-box, with which it is supplied. O and O′, stage and spring for the reception of slides and pictures: this is of a most convenient form, allowing the top

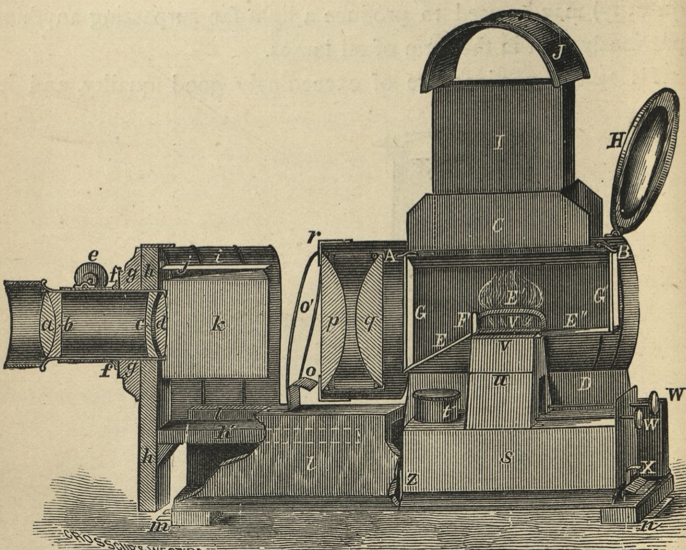


Fig. 8.

to be open for the introduction and manipulation of chemical, photographic, and other scientific experiments. P Q, the condenser lenses, 4 inches in diameter, and of short focal length, mounted on a very approved plan, which permits of either lens being removed from its cell. S, the lamp reservoir, of sufficient capacity to hold, when full, enough oil for four hours' entertainment. It is not advisable to fill this reservoir too full, and care should be

taken not to allow any oil to get outside, in which case an unpleasant smell is sometimes produced. U and V, tubes carrying 1½-inch wicks, each of which are disconnected in their length, thus preventing the transmission of heat from the flame to the oil-chamber, and by keeping the oil quite cool, avoids any objectionable odour. W W, buttons for adjusting the wicks. E E′, interior of flame-chamber, the whole of which is in no way connected with the lamp, thus avoiding the conduction of heat downwards. Between the flame-chamber and the exterior portion a cavity is left, to insure thorough circulation of air, and by which the instrument is kept cool. F, a narrow strip of glass, introduced to give an upward direction to the heated air: it has no liability to break, and moreover it is a protection to the glass (G). G G′, are a pair of glasses closing the ends of the flame-chamber; their liability to fracture has been entirely overcome by using toughened glass. H, concave silvered reflector, also used to close the back of the instrument. I and J, chimney and cap, which are made telescopic, and can be taken off for convenience of packing.

The merits of such a powerful oil lantern must be apparent to all. One objection has been raised to it, namely, that of a slight shadow crossing the illuminated disc, in a vertical direction; but this is of so little consideration, that when a picture is being shown it is not perceptible, except with such slides as show a great amount of sky, and in this case it can be reduced to a minimum by a proper attention to the wicks. Other modifications of double-wicked lanterns have been introduced, but it cannot be said with much improvement. One of these was to contract the wicks at the front ends, and to expand them at the back, to obviate the seeming defect of the dark line above mentioned; but after considerable experience with one of this class, the author found that by this placing of the wicks out of parallel, the flame was more

likely to "fork" and the wicks to burn unevenly, and after some time a portion of the illumination was sacrificed.

Other forms of both double and triple-wicked lamps have since been introduced. The one styled the "Patent Refulgent Lamp" is constructed both with double and triple wicks, and possesses merits in many ways which go to prove its excellence. There is also a triple-wick lantern recently introduced—the "Triplexicon." This, too, is a lantern with many excellent points and features which, in the author's opinion, gives it a place parallel with those previously referred to.

The "Sciopticon," as well as those above mentioned, are now adapted so that the lime light can be introduced.

THE PYRO-HYDROGEN LIGHT.

HAVING now completed our review of the family of oil lanterns, it may be as well, before entering into a description of the Oxy-Hydrogen Lime Light, to describe a light lately introduced for lantern purposes. The light alluded to is produced by a pressure of hot air and hydrogen impinging upon a piece of lime. Several attempts have previously been made in this direction, but until a short time ago no practical result had been achieved. However, a lamp of German invention was some months ago introduced, and modified by Mr. W. B. Woodbury for lantern purposes, and styled by him the "Pyro-Hydrogen Lamp," which is shown at Fig. 9. Accompanying the same is a blowing apparatus to be worked by hand or foot, and by which a strong current of air is forced through the spiral tube surrounding the hydrogen tube. Both gas and air, being heated to a high temperature in

transit by a powerful Bunsen burner, shown underneath, issue from the jet in the form of a fine blue flame, which when projected upon a disc of lime renders the latter so incandescent that a light is produced, although not equal to the oxy-hydrogen or oxy-calcium lime light, is superior for some optical purposes to any oil light with which the writer is acquainted.

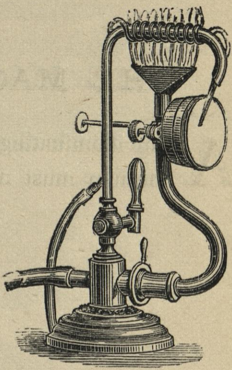


Fig. 9.

At the bottom of the burner is an ingenious description of tap, which regulates at one movement both gas and air, and in proper proportions to secure the best effect of a Bunsen flame. By entirely closing this tap, the lamp may be used for oxy-hydrogen lime light, and for which purpose it is admirably adapted. The lime-holder is adjustable by a wooden end to prevent burning the fingers, and is arranged to carry discs of lime 1¾ inches in diameter. There is every reason to believe that this light, when worked from a steady pressure of air (which might be best obtained from a vessel to which water pressure is applied), will rank as one of our powerful and economical artificial lights for both scientific and ordinary purposes.

Soon after the introduction of the "Pyro-Hydrogen Lamp," another form was introduced with the object of obtaining a "lime light without oxygen." In this air was used, as in the previous one, under pressure, combined with hydrogen, but without being heated. The first of these lamps which came under the writer's notice was exhibited and experimented upon at one of our scientific societies' meetings, and the general impression produced was unfavourable, thereupon the writer purchased one so as to test its merits, and

after several trials with the same, was compelled to conclude that for optical or photographic purposes it is entirely useless.

THE MAGNESIUM LANTERN.

AS an illuminating power the combustion of the metal magnesium must not be omitted. As adapted to the Magic

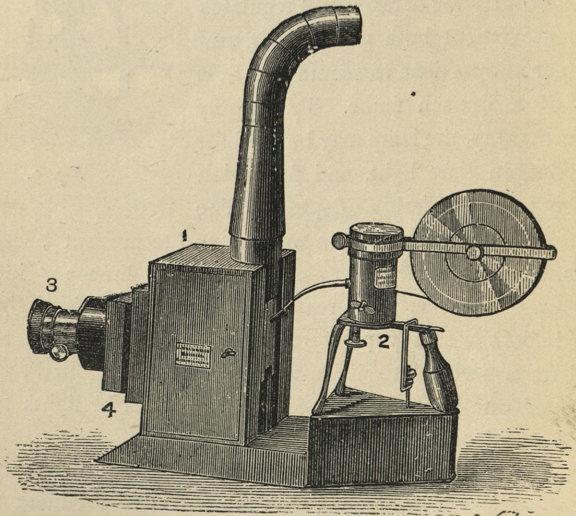


Fig. 10.

Lantern its success has been limited, principally owing to the unsteadiness of the light, and to the necessity of providing a long chimney to carry away the great amount of magnesia vapour, the result of the combustion. For these and other reasons it is not

used for Magic Lanterns generally, but may be adopted in the case of a lecturer or experimentalist wishing, during his lecture, to show an occasional diagram. The most practical apparatus of this kind is, perhaps, the one manufactured by Mr. Solomon, of Red Lion Square, London, and is constructed to burn the metal in ribbon or wire form, and is fitted with an ingenious clockwork arrangement for self-feeding. The arrangement of lamp and lanterns are clearly shown at Fig. 10.

THE LIME LIGHT.

THE "Lime Light" or, as it is sometimes styled, the "Drummond Light," has been in use as far back as the year 1820. It consists of a jet of oxygen blown through a flame of hydrogen on to a piece of lime, which latter is rendered so extremely incandescent, that a light is obtained superior in importance to any, the electric excepted. Sometimes the flame of a spirit lamp is substituted for that of the hydrogen; it is then known as the "Oxy-Calcium Lime Light." Before proceeding to enter upon the different methods of using the gases, it will perhaps be as well to explain the mode of their manufacture.

OXYGEN GAS.

Where the manufacture of oxygen gas, not only for illuminating purposes, but for sanitary purposes also, is conducted on a large scale commercially, the method of M. Tessié de Motay is usually adopted. Briefly described, it consists in heating in a large retort manganate of soda, and blowing through it high-pressure steam, which carries with it the oxygen contained in the manganate of

soda. After all the gas has been extracted, the steam is shut off, and air is introduced to the retort, which restores to the manganate of soda the oxygen in place of that which had been extracted. It is then subjected again to the steam jet, and so on with steam and air alternately, the manganate of soda being always replenished with oxygen on the admission of the atmosphere. A large manufactory on this principle was established at Brussels, as also in many of the large cities in America, where oxygen gas is produced as cheaply as 25*s.* per 1,000 cubic feet.

In England the making of oxygen gas is usually conducted on a small scale, consumers having generally to prepare their own; but it is to be hoped that ere long we may be blessed with similar advantages, and have the opportunity of purchasing oxygen gas at a rate somewhat proportional with that of house gas. There are various other methods of producing oxygen gas than the one above described, but as our object in this treatise is to produce in quantities suitable for lantern requirements, it is only necessary to speak of the most practical and economical methods of arriving at this result.

From one pound of chlorate of potash in the form of crystals or powder, to which one-third of a pound of black oxide of manganese has been added, together heated in a retort, four cubic feet of oxygen gas may be obtained, although theoretically there should be more. The exact proportion of this mixture is not of importance, as the manganese undergoes no chemical change under the operation, the oxygen being wholly derived from the chlorate of potash, which, if used alone, would liquefy on the application of heat, and give off the gas so quickly as to be ungovernable. The addition of the manganese is merely to separate the particles of the chlorate, so that the gas when given off may be more under control; also by its addition less temperature is required. After

all the oxygen has been given off, the residue is chloride of potassium and oxide of manganese: the former being soluble in water, may be separated from the latter by decantation, and after drying may be used again and again with an assurance of its purity. The greatest care must be exercised in the purchase of these chemical ingredients, as the introduction of any organic matter into the retort on heating, the same would ignite, and a serious explosion would be the inevitable result. Some years ago an acquaintance of the writer's, who in the exercise of his profession had made this gas a thousand times, one day upon being called upon for a bag of gas, found his stock of manganese exhausted, he therefore sent out to a neighbouring chemist's shop for a supply. By some means the manganese had been accidentally mixed with soot, which in appearance it somewhat resembles, and on using some a fatal accident resulted. Although it is very rarely that manganese is intentionally adulterated, it is well to be on the safe side, and safety from such accidents as the one alluded to may be obtained by heating the manganese to redness in a crucible before mixing it with the chlorate of potash. This is a simple matter, and should be done with every fresh sample. By reason of its small cost it may be purchased in sufficient quantity to last a season. Care must also be taken that no deleterious substance enters during the roasting. If desired, fine sand may be substituted instead of manganese, but it must be previously rid of any organic matter.

Retorts best suited to oxygen-making are those made of sheet iron, conical in shape and brazed together, having a dish bottom and a brass top, on to which latter is attached by screws a loose brass cap with a piece of bent wrought iron tube screwed therein.

As a medium for making the joint between the retort and the

cap, the writer advocates "asbestos," which is very durable and effective.

The gas in passing from the retort (if to be stored in a bag) should pass through a wash-bottle, sometimes called a "cooler" or "purifier," consisting of a "Woulfe's Bottle" partly filled with water. The tube connecting the retort with the wash-bottle may be partly of lead and partly of india-rubber, the leaden portion being of sufficient length to reach nearly to the bottom of the

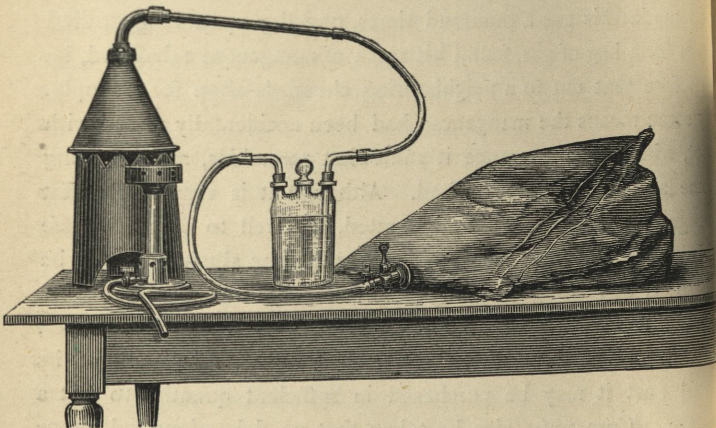


Fig. 11.

bottle, and should be perforated with small holes at some distance from its end, thus forming a rose-head. The gas in passing through the water will be purified, cooled, and rid of any particles of manganese, which are sometimes carried away with the gas from the retort, and which are apt to choke the nozzles of the jet if the washing be omitted. The outlet-pipe should be a bent tube long enough to enter the bottle, and sufficient in length to connect with the gas-bag. The whole arrangement is illustrated at Fig. 11.

The retort may be heated on a fire, or by gas, which latter is preferable, a large Bunsen burner being placed in the conical stand, which is of sheet iron, and forms a support for the retort. The Bunsen burner has been shown out of position to illustrate the kind adopted.

So soon as the gas has been given off (which may be noticed by the cessation of bubbling in the wash-bottle), the tube connecting the retort with the wash-bottle should be disconnected; if this be neglected, and the heat from the retort withdrawn, a vacuum will be caused on cooling, which will draw the water from the wash-bottle into the retort, and a miniature boiler explosion

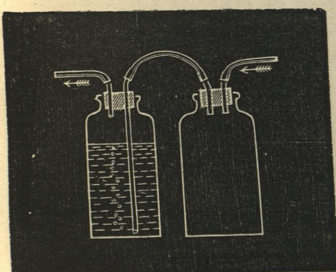


Fig. 12.

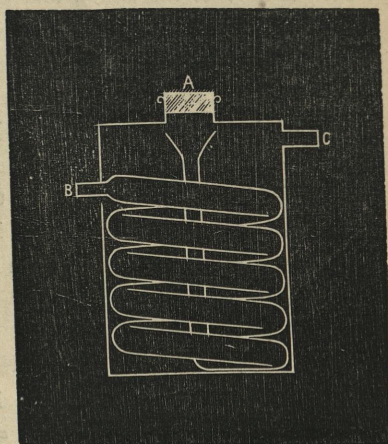


Fig. 13.

will very likely be the result. To obviate this, an empty bottle may be placed in the tube between retort and wash-bottle; thus in case of a vacuum being created, the water in the wash-bottle would be simply drawn as far as the empty bottle, without proceeding farther.

Some time ago the author constructed, from an idea of F. Bogen, Esq., a wash-bottle answering the purpose of the two

mentioned previously, and shown at Fig. 12. It consists (Fig. 13) of a spiral lead pipe coiled inside a tin vessel. At A is a good fitting india-rubber stopper, which can be removed for filling the coil with water, for which purpose the upright pipe connected with the bottom of the coil has a funnel-shaped top, and is higher than the outlet at B; so that should water be poured into the coil, so soon as it is full it will overflow at B.

The spiral tube being filled, the connecting-tubes are fixed thus: The one from the retort to the inlet C, and the one to the gas-bag to B. Now, as there is nothing but air in the space surrounding the spiral, the gas will soon drive this out, and will descend the upright tube of the spiral, and bubble through its entire length (some three or four feet), therefore gaining the advantage of six or seven times the washing obtainable in an ordinary bottle, and only the same amount of pressure is required.

Now, should the retort be deprived of its heating power, and a vacuum be caused to form in both wash-bottle and retort, the water will be simply drawn from the coil, and fall into the space surrounding it, the area of which is in excess of that of the coil; therefore no water whatever can pass into the retort, and no accident can possibly occur.

HYDROGEN GAS.

It is beyond doubt that pure hydrogen is superior, both in illumination and in economy, as compared with house gas (carburetted hydrogen). Not only is less of it required, but also less oxygen to produce an equal result, though the trouble of making it does not always repay the advantages gained. In most large towns in this country a fair pressure of house gas can be had, and for all ordinary lantern exhibitions this is used direct from the main in what is called a "safety" or "blow-through jet."

When the pressure is feeble, as it usually is in small towns, it is customary to fill a gas-bag from the main, and to use same under pressure, in the same way as the oxygen. Hydrogen gas is produced by the action of dilute sulphuric acid upon zinc; the gas being liberated and sulphate of zinc being deposited. At Fig. 14 is shown a general arrangement for the purpose of making

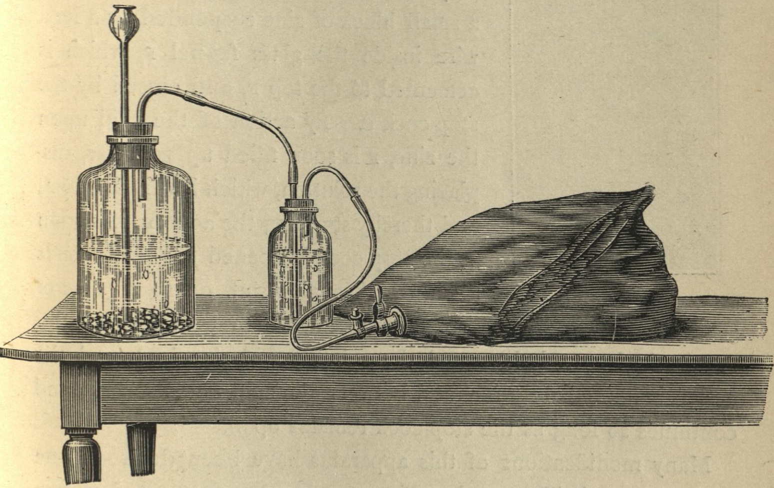


Fig. 14.

this gas. It consists of a glass bottle, with a good tight-fitting cork, and a funnel-top tube extending nearly to the bottom of the bottle, through which the sulphuric acid and water (in the proportion of 6 of water to 1 of acid) are poured, and thus brought into contact with granulated or clean zinc cuttings lying at the bottom of the bottle. The gas should be allowed to blow through for a short time to get rid of the air contained in the bottle at starting, and then may be collected by the bent tube from the upper portion of the vessel. If the gas is to be used from a bag, it

should be washed in like manner as the oxygen, as shown in the engraving.

Doelberner's Lamp (Fig. 15) is an automatic hydrogen generator, and may be made of large size if required. A is a glass cylinder containing a very dilute solution of sulphuric acid; Z is a small block of zinc suspended by a lead wire inside the glass funnel F, which is cemented to the top E, and closed by the stop-cock C. By action of the acid upon the zinc, F is soon filled up with gas, displacing the solution, which is driven into A, and thereby stopping the action. As soon as the stop-cock is opened the hydrogen is liberated, through a jet, on to a piece of spongy platinum, which produces a light.

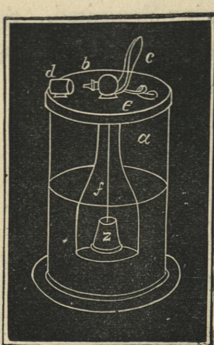


Fig. 15.

As the hydrogen is liberated the solution will rise in F, and the action is immediately renewed between the acid and the zinc, and continues so long as the stop-cock remains open.

Many modifications of this apparatus have been devised: one by the author is illustrated at Fig. 16. It was constructed of two large preserve-jars, the top jar having the bottom cut out, and it was fixed in an inverted position over the bottom one by a good deep india-rubber stopper, made of a block of india-rubber, fitting each jar-mouth tightly, and through which a lead tube passed to the bottom of the under jar. Upon this lead tube was fixed a cylinder of zinc. The outlet pipe was also a leaden tube secured into the india-rubber stopper. The apparatus was charged by filling the bottom jar with sulphuric acid one part, and water six or seven parts; then by connecting the upper jar the gas was quickly generated, and the liquid forced up the leaden tube into the upper

jar. A steady pressure could be maintained with this apparatus,

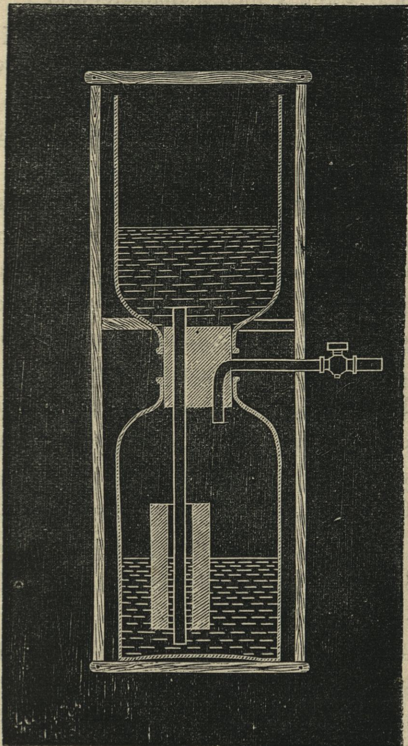


Fig. 16.

which was wholly enclosed in a neat wooden box with a loose top and front.

LIMES.

Limes for use with the oxy-hydrogen light may be purchased in two forms, and of two kinds and qualities—namely, discs and cylinders, hard and soft, and good and bad. Shape is of little

importance; the one most in general use and perhaps most convenient is cylindrical, about 1 inch in diameter and $1\frac{1}{2}$ inches long, perforated in their entire length with a hole $\frac{3}{16}$ inch in diameter to fix them on to the lime-pin of the jet. Discs are made of two sizes, $1\frac{3}{4}$ and $2\frac{1}{2}$ inches in diameter. Hard limes are found best suited for the oxy-hydrogen and high pressures, soft ones being best for oxy-calcium and low pressures.

As lime has a powerful affinity for moisture, and will not keep intact if exposed to the atmosphere, it is necessary to wrap them in tinfoil after they are made, and pack them in an air-tight box or bottle large enough to contain a dozen. An excellent plan for preservation is to dip them in a solution of india-rubber in benzole. It is not an unfrequent occurrence, and one not a little annoying, to find upon opening a box of limes that moisture has gained admittance, and that the limes are slacked and worthless. Many substitutes for lime have been tried with more or less success; the best of these which has come under the author's notice being the oxide of zirconium, which is described by Du Mothay as "the most infusible, unalterable, and the most luminous substance at present known."

Many years ago the author purchased an oxy-hydrogen lamp of French manufacture, in which a small piece of oxide of zirconium was used instead of lime, but he found that it was not so imperishable as it had been represented. By the continuous action of the oxy-hydrogen flame for a few hours it decreased materially in size; however, it was a step in the right direction.

Artificial limes have previously been described and made by many lanternists, and to this subject the writer has devoted considerable time and expense, with the object of producing an efficient substitute for the crude lime. Firstly, he constructed a powerful press in which to form the different mixtures, many dif-

ferent ones of which he tried. Although the worst of them would keep indefinitely under exposure to the air, the best, however, wore away under the action of the oxy-hydrogen flame. It may be remarked that, when under low pressures, a far superior light was obtained in many instances than even with soft limes, but their want of durability was a decided objection. It is as well to possess a few artificial limes in case of emergency, and for the lecturer who may only require a light occasionally, perhaps the best for such a purpose is made of

Precipitated chalk	8 parts
Carbonate of magnesia (ponderous) .	1 ,,

mixed together, with the addition of a little very thin gum water, and subjected to a good pressure in a hydraulic press. At some future period the author hopes to renew his experiments in this line, and trusts to find, at all events, a better substitute for lime than he is at present acquainted with.

In preference to purchasing, many make their own limes, which can be done from a block of unslaked lime, to be obtained in almost any town in the kingdom.

GAS-BAGS.

These have been the receptacles in most general use for the gases used in lime-light effects. They are made of mackintosh cloth in the form of a wedge, and of two qualities, the best being made of three thicknesses of cloth, with india-rubber inserted, of black material generally, and are in the end by far the cheapest and most serviceable. Those made by Mr. Pumphrey, of Birmingham, are of first-class quality, and in addition supplied with an excellent arrangement of lock-up tap. When out of use the bags are liable to become somewhat stiff: this can easily be removed by warming for a short time before a fire.

For those who may by accident chance to have a leaky gas-bag, it is well to mention an excellent remedy, which in all cases of emergency will prove effectual. This is a piece of common sticking-plaster made hot and applied. The author has known this method to be used in cases where india-rubber solution has been out of reach, and it has answered admirably until a better remedy could be applied.

When both a bag for oxygen and one for hydrogen are used, they must be kept for their own respective gases, and not interchanged, each being marked O or H to signify their contents; therefore, whenever a bag is to be filled, all old gas and air should be expelled by folding the bag with the tap open, and before unfolding the bag the tap should be closed, to prevent any air being sucked back. As soon as the connections are made the tap can be opened. When bags have to be transported about or sent by rail, it is a good plan to have a loose outer covering of canvas or similar material.

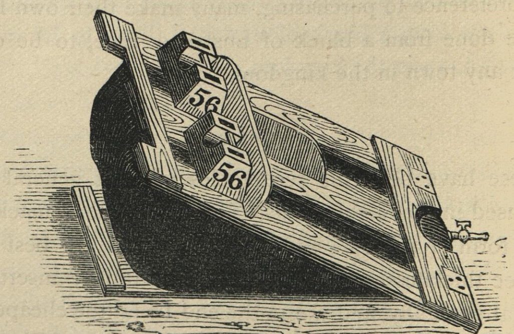


Fig. 17.

PRESSURE BOARDS

Are necessary with gas-bags, to form a means of applying weights.

They consist of two boards hinged together at one end, with a semicircular hole cut in same end to allow pipe and tap to project. A hinged shelf is usually fixed on the top board, upon which the weights are placed (see Fig. 17). This is the best form of pressure board, being a pure lever, with the fulcrum at the hinges. Sometimes a single board is used, which is fixed by hooks placed in the floor at the lower end of the board.

When using both oxygen and hydrogen from gas-bags it is of

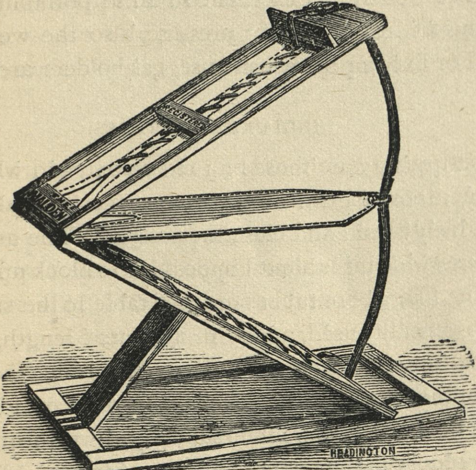


Fig. 18.

the utmost importance to have the pressures equal. With this object, a pressure board was devised by Mr. Malden to contain two bags, with which one set of weights are sufficient, and the pressure equal in both bags. The most portable form of this is manufactured by Mr. Middleton, of High Holborn, London, shown at Fig. 18. As will be seen, it is composed of a wooden frame-

work, with canvas inserted, and by straps at the back the bags are prevented from slipping. Weights are never included in a travelling lanternist's outfit, being always obtainable in some form or other everywhere.

The weight necessary to give sufficient pressure on large bags for oxy-hydrogen mixed gases is as much as two hundredweight, and sometimes more, but with safety jets and oxy-calcium half this amount is usually sufficient. Although the method of gas-bags and pressure boards is excellent so far as portability goes, it has the failing of inconstancy of pressure, also the wear and tear is great. For fixed or permanent use, gas-holders are highly preferable.

INDIA-RUBBER TUBES.

The best quality are those of a red colour, and when cost is not considered, those of extra thickness are most suitable, as they do not so suddenly bend and close the passage. The author has some of this class, which it is almost impossible to block up in the passage by bending. Large-bore tubes are preferable to the small-bore ones we see so generally used, and if of any great length, should be at least ½ inch internal diameter. It is astonishing how small a reduction in the passage will reduce the pressure considerably. Tubes should not be used that are internally lapped with iron wire, as the wire only reduces the pressure and causes friction. In the coupling of tubes, see that the couplings are as large in the bore as the tube: often this is not the case, but the coupling is the same diameter outside as the tube is inside. An easy method of coupling is to turn the tube inside out for an inch or so, then insert the coupling and pull the tube back again to its original form.

All taps should be looked to, to see that there is a full and free passage through them, as not unfrequently the plug is bored with a hole not one-half the area of the tube. It is, therefore, always

desirable to use taps of a size larger, with the plugs well cleaned out.

GAS-HOLDERS.

Where the lime light is often required in one fixed place, gas-holders claim many advantages over gas-bags. No wash-bottles are required; the gas does not deteriorate in quality by being stored; and, if properly constructed, one even pressure can be maintained;

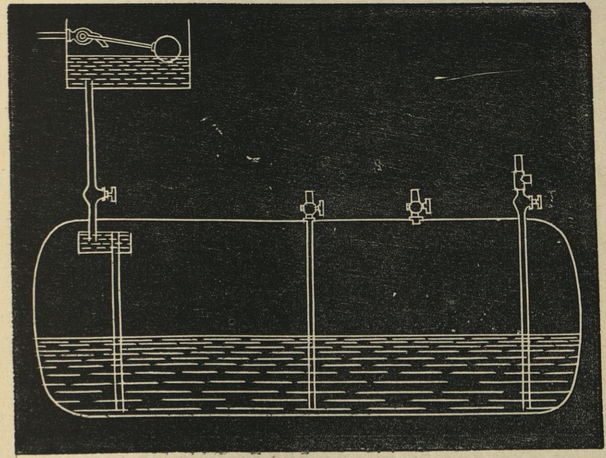


Fig. 19.

none of which advantages are to be derived from gas-bags and pressure boards. Gas-holders are sometimes made of zinc, but more frequently of iron. A friend of the author's has a very good and useful one fixed in his garden, and made of two casks, the outer one being sunk into the ground, and the inner one inverted, forming the holder. For a cheap article this is a very effective one, although not very elegant in appearance.

The best gas-holders that have come under the author's notice

were two that he constructed for a friend. They were made in shape similar to a small dish-end steam boiler, of wrought iron plates $\frac{1}{8}$-inch thick, well riveted together. A man-hole was cut in, and a cover for same attached (as in a steam boiler), by which a boy could get inside and clean out and paint when necessary. A cut of same will be seen at Fig. 19. The pressure was applied by water from a cistern, and conveyed to the inside of the holder by the pipe P. The end of this pipe was covered with a small quantity of water placed in a cup, open at the top, and from this cup another pipe takes the overflow to the bottom of the holder, so as to avoid the splashing and noise. The amount of pressure is regulated by the distance between the surface of the water in the cistern C, and the surface of the water in the cup inside the holder. No matter how much or how little gas be in the holder, the pressure is always uniform. The pressure can be increased or decreased by increasing or decreasing the distance between the two surfaces of the water, as before stated. G is the gas outlet, I is the inlet, W is the pipe to empty the holder when filling with gas. For a fixed apparatus, this one, perhaps, presents the best advantages.

Portable gas-holders have also had the careful consideration of scientific men, and at Fig. 20 will be seen an excellent form of portable gas-holder, designed by Mr. S. Highley, which was exhibited by him in the Exhibition of 1862, and is described by him thus:—

"This I originally designed for a professor's lecture-room, where only small quantities of oxygen were required at a time, for the display of an occasional diagram in illustrating a course of lectures, and to avoid the daily and frequent production of oxygen. Fig. 21 shows how I contrived this arrangement, so that the lantern could be packed in the body of the gasometer for travelling, if necessary."

When unpacked and arranged as in Fig. 20, it will be seen that the "bell" which holds the gas is square, instead of cylindrical,

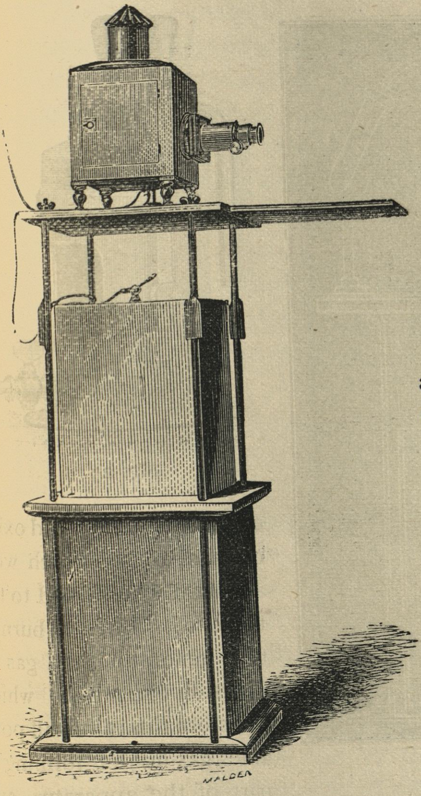


Fig. 20.

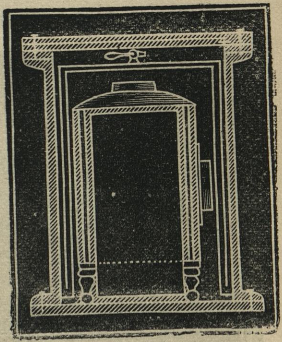


Fig. 21.

and slides into a double casing, shown in section (Fig. 21), that is filled with water, so as to form an air-tight water-joint for the run of the bell, and to reduce the bulk of the water required to a minimum. It was also designed as a stand for the lantern as shown. Although this apparatus was well adapted for the lecturer, experimentalist, or photographer, it was of insufficient capacity for lantern exhibitors generally. The want of some apparatus by which a supply of oxygen could be maintained in connection with a port-

able gas-holder was in 1868 supplied by Mr. M. Noton, who was the first to describe the generating of oxygen gas at the time of consumption, by means of small retorts charged with plugs of

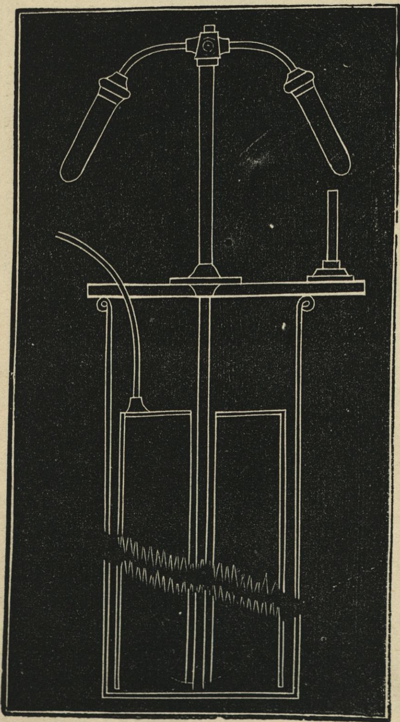


Fig. 22.

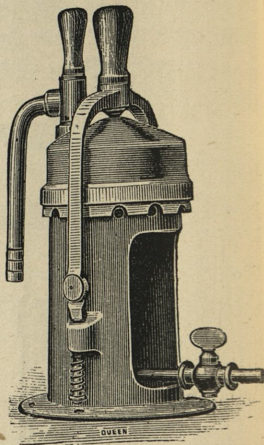


Fig. 23.

chlorate of potash and oxide of manganese, which were alternately subjected to the flame of a Bunsen burner, thus generating the gas as occasion required, which was stored in the small portable gas-holder forming a part of the apparatus, and used therefrom (see Fig. 22). The plugs used were moulded while the mixture was in a damp state, and, after being dried, were ready for use.

A difficulty was experienced in extracting the spent plugs, for

re-charging which necessitated the use of four, six, or more retorts, depending upon the quantity of gas required.

To obviate this difficulty, and to dispense with a number of retorts, the author designed a retort in which flat cakes could be used instead of plugs or cylinders. It was also arranged with due consideration to perfect safety, and the entire removal of fear from the minds of inexperienced experimentalists.

The principle of the retort or generator will be clearly seen from the accompanying woodcut (Fig. 23). It consists of two pieces, a flat plate, and a bell-shaped cap, supported by a stand in which is placed a Bunsen burner of improved construction. The cap has an aperture at the top, in which is screwed a pipe, etc., for conveying away the oxygen as made. In other respects the retort proper consists of two simple iron castings turned and ground to a gas-tight fit. The fastening consists of a bow, clearly shown in the woodcut, at the extremities of which are small spiral springs, so adjusted as to maintain a pressure equal to 1½ lbs. per square inch, which pressure is far in excess of what is ordinarily required for lime light purposes. Now, it is obvious, should the passage from the retort be closed (although in this apparatus there is no likelihood of such an occurrence), the pressure in the retort would rise until it had arrived at a pressure of 1½ lbs. per square inch, when the gas would escape through the joint; and, as soon as the passage was clear again, the gas would take its right course, relieving the pressure inside the retort, and by virtue of the spring the joint would close, and the top assume its original position. When exhibiting this apparatus at several scientific societies, to illustrate its safety qualities, as the gas was coming off rapidly the outlet pipe was closed (by means of a tap purposely introduced), and the oxygen, still being generated, escaped through the joint as intended with perfect safety. To open the retort for re-charging,

etc., pull over the wood handle fixed to the top of the bow, and the cap may be then removed by the wood handle fixed thereto, and, to close the apparatus, reverse these operations. The handles being made of wood prevents the fingers from being burned when in use.

The method of making the cakes is as follows: To four parts chlorate of potash and one part manganese, add sufficient water to moisten, not to wet; after mixing well, fill the mould, using little pressure, smooth off the surplus with a dinner knife or a

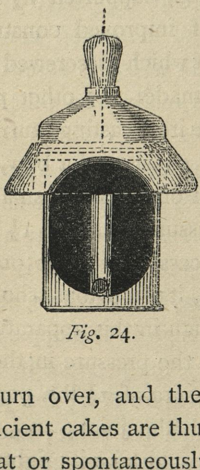


Fig. 24.

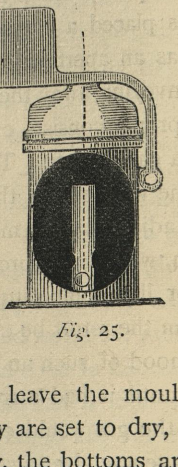


Fig. 25.

spatula, turn over, and the cakes will leave the mould entire. After sufficient cakes are thus made, they are set to dry, either by gentle heat or spontaneously; when dry, the bottoms are coated by dipping into a mixture of manganese and water about the consistency of cream; when dry, they are ready for use. This coating of the bottom of the cakes with plain manganese is to prevent the spent cake sticking to the retort, being the only part in contact with it. These cakes leave the retort in their entirety, only somewhat distended; they are easy to produce, clean to handle, and as hard as a piece of coal.

In addition to the retort shown at Fig. 23, other forms were devised by the writer.

The one, Fig. 24, for dead weight. Another, Fig. 25, for lever and weight.

The writer has also designed a retort for the use of plugs or cylinders, to which was applied the safety-valve in the dead-weight form. The principle will be fully understood by reference to the drawings; Fig. 26 showing the retort open; Fig. 27 showing it

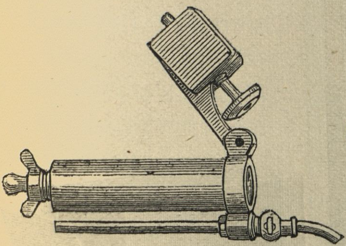


Fig. 26.

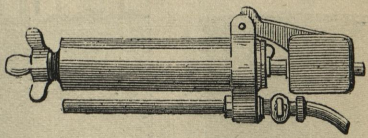


Fig. 27.

closed. If the pressure in the retort should from any cause rise in excess of that to which it is weighted, the gas would be liberated at the front end by virtue of the weight which is hinged to the retort, and has attached to it the cap-lid in such a manner as not to be quite rigid, but is free to move a little so as to find its proper position. On the cap-lid is a small projection shown in Fig. 27, for the purpose of removing any substance which might interfere with the joint, and also permits of the lid being ground into its proper bed. The method of opening and closing the retort is simple:—Turn up the weight and the retort is open, or turn down the weight and it is closed. Plugs of chlorate of potash and manganese may be made and used in thin sheet-iron cases, if preferred; or a method I have adopted is to make the plugs on a

wire, with a sheet-iron disc at the bottom end, and a small loop at the other (just resembling a sugar-crusher).

As soon as the plugs are dry (which they become much sooner than when bottled up in a tin case), dip them in plain manganese

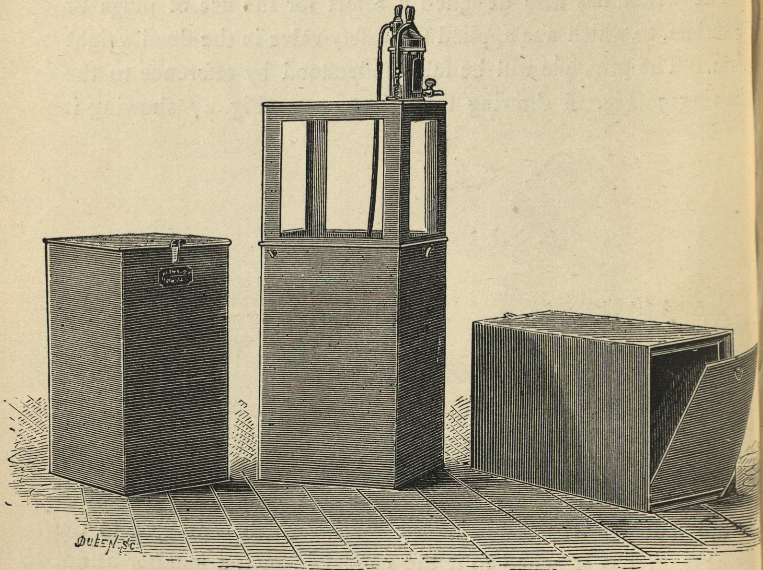


Fig. 28. *Fig.* 29. *Fig.* 30.

and water; this when dry prevents any adhering to the retort. Should the plug break, or any part become detached, the disc at the plug end attached to the wire, on being extracted, brings all with it.

The gas-holder used in connection with these generators is a modification of the one introduced by Mr. S. Highley, and described at page 42. At Fig. 28 the whole apparatus is shown packed for

travelling, with lanterns, etc., packed in a dry compartment. Fig. 29 shows the apparatus as at work. Fig. 30 shows the under side of the apparatus; and the lid, with lock-up arrangement, partly open, displays the portion used for packing, formed by the displacement-chamber, around which the water luting for the bell is poured when in action. Fig. 31 illustrates the apparatus used as a stand for the lantern.

When in use the pressure is applied by placing water in a reservoir provided for that purpose, thereby maintaining one uniform pressure throughout, which can be regulated according to the quantity of water used. If more convenient, any other substance than water may be adopted tor weighting.

Thus by using this apparatus, portability is obtained, gas-bags, pressure boards, and weights are dispensed with, and a continuous supply of oxygen ot even pressure with perfect safety is maintained.

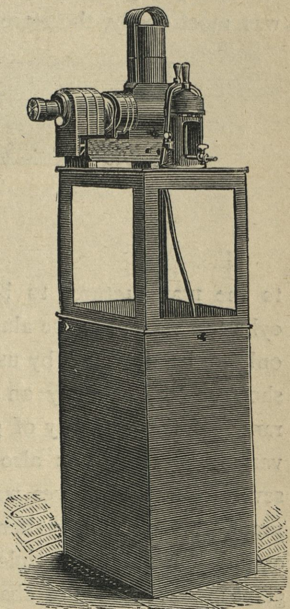


Fig. 31.

CONDENSED GASES.

In America, where oxygen is manufactured commercially, cylinders of sheet iron (Fig. 32) were introduced, into which both oxygen and hydrogen were compressed to about 250 lbs. or 300 lbs. per square inch. This plan was also adopted in Brussels, where oxygen is largely used for ordinary illuminating purposes. It has also

been introduced into this country, but on a much smaller scale, and, although possessing the excellent advantages of portability and convenience, it was nevertheless open to objection. The machinery required for pressing the gas up to the required degree was most costly, therefore it was necessary to send the cylinders

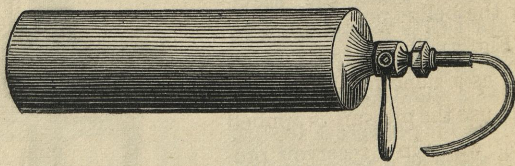


Fig. 32.

to the manufacturer to be filled when empty. Sometimes the cylinders proved to be almost empty instead of full, and this was only to be detected by using a pressure-gauge on each, and the shortcomings of many an exhibition have been caused by ignorance of the quantity of gas stored in the cylinders. An ever-varying pressure was also another objection. To obviate this, several forms of valves were introduced, but none of any good practical use. The writer devised a valve on the reducing and equilibrium valve principle, which acted moderately well, but the great inconvenience of charging the cylinders has condemned the system.

JETS.

By far the most powerful and economical form ot jet is the oxy-hydrogen jet (Fig. 33) often called the Mixed Jet. As will be seen in the illustration, each gas is carried in a separate tube to a chamber under the nozzle, in which chamber the gases are mixed just before ignition. For the successful working of this jet it is imperative that both the oxygen and hydrogen be under equal pressure.

Originally the oxygen and hydrogen were mixed in the bag, in the proportion of one part by volume of oxygen to two of hydrogen, and only one tube was necessary; but this was a most dangerous proceeding, for should the pressure be relieved by any chance from the bag containing the mixed gases at the time the light was burning at the nozzle of the jet, the combustion would be instantly carried down the supply-tube and a fearful explosion would ensue. It was found safer, therefore, to use the gases in separate bags, and to mix them in the chamber for that purpose just previous to ignition at the nozzle of the jet; but even in this case, if the bags

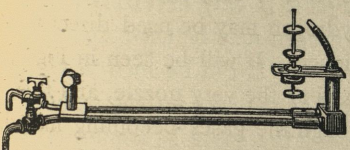


Fig. 33.

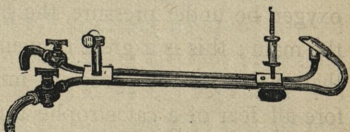


Fig. 34.

be not equally weighted (a case which might easily occur through unequal sizes of bags or pressure boards, or by substituting manual pressure for weights), the gas under the heaviest pressure would be forced into the other bag, and, as in the former case, the relieving of the pressure would terminate the proceedings with equally dangerous results.

An accident of this class occurred in the presence of the writer, through a gentleman inadvertently putting his foot on to the bag to give a little more pressure: as soon as he withdrew it a fearful crash was heard; fortunately no one was injured, but the sudden concussion of the air produced a temporary deafness, besides more or less destruction to all the apparatus around.

So let it be borne in mind that when using mixed gases, never to relieve the pressure or adjust the bags or weights in any case

when the light is burning. The best effect from a mixed jet is obtained at high pressures. The author has used this form of jet at a pressure equal to a column of water 60 inches in height: in this instance it is necessary to use hard limes, and a clockwork arrangement to automatically rotate the limes, and gradually give to it an upward motion.

"*The safety*" oxy-hydrogen jet or "*blow-through*" jet, although inferior in illuminating power to the above, is usually sufficient for pictures of 12 to 14 feet diameter; but it must be mentioned that more gas is consumed to produce the same result than is required with the mixed gases. With this jet it is only necessary that the oxygen be under pressure, the hydrogen may be used direct from the main; this is a great convenience. It will be seen in Fig. 34 that in this jet the gases are mixed at the very nozzle, and therefore all fear of a catastrophe through the gases becoming mixed, even under unequal pressure, is abolished.

The hydrogen is conducted up the left-hand tube, the extremity or nozzle of which is of wide bore, the oxygen being conveyed in the right-hand tube, and from a fine nozzle is blown through the hydrogen. Softer limes may be used with this jet to advantage.

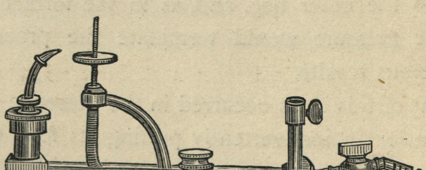


Fig. 35.

An exceedingly ingenious arrangement for turning and adjusting the lime from the back has been adapted by Mr. Middleton of High Holborn, and which is illustrated at Fig. 35 and Fig. 36.

A spiral spring of fine steel wire is attached to the end of the lime-pin, and the other end of the spring is fixed to the extremity

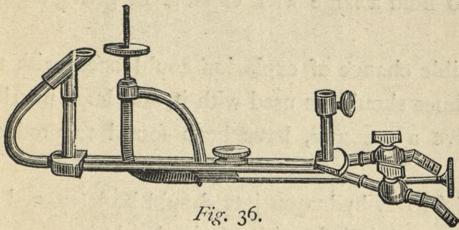


Fig. 36.

of a rod running parallel with the tubes and at right angles with the lime-pin. When this rod is turned by the milled head shown in the illustration, the motion is communicated to the lime-pin through the spiral spring, and therefore the lime may be turned, raised, and lowered at will without opening the body of the lantern, and besides being neat and strong, these jets are provided with platinum nozzles, the whole is of a superior class workmanship, and at a very moderate price. Fig. 35 is the oxy-hydrogen or mixed jet, and Fig. 36 is the safety jet.

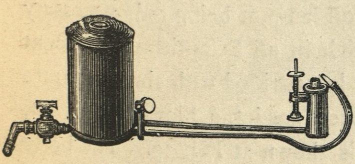


Fig. 37.

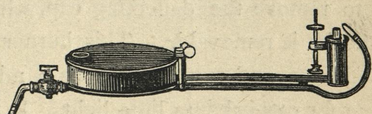


Fig. 38.

OXY-CALCIUM OR SPIRIT JET.

This jet is only used when hydrogen is not obtainable or inconvenient to get at. Many modifications of this style have been devised with more or less success. Those illustrated at Figs. 37 and 38 are good forms of this kind of jet.

It is very essential that the reservoir for the spirit be kept cool, also accessible for re-charging with spirit, and that the wick-holder be made to hold a large wick capable of giving a good compact flame.

No possible chance of explosion could occur with this form of jet. Soft limes should be used with it, and large nozzles, with not too excessive a pressure, have been found to produce the best results.

The taps for oxy-hydrogen jets should be lacquered of different colours, so as to be distinguishable in the dark.

It is important that no solder be used in the construction of the jets, and that the nozzles are removable or accessible for cleaning. In jets of the best quality the nozzles are made of platinum. The lime-pins should be large enough to hold two limes one above the other, so that in case of accident to one lime another is close at hand, warm and ready for use. A small pair of tongs are useful in removing broken limes.

A most ingenious burner has been devised for use with the Sciopticon, by Mr. L. Marcy, the inventor of that instrument. It takes the exact position of the oil lamp, it being only necessary to remove the deflecting cap, which in all Sciopticons of recent make is removable. This burner is provided with three separate nozzles, and can be used as a mixed gas-jet, a blow-through jet, or for oxy-calcium lime light. It is shown at Fig. 39. The body B is formed of a block of hard wood, upon which the various parts are mounted. At O and H are the taps for the admission of oxygen and hydrogen, and which are made dissimilar, so that each may be readily distinguished in the dark. Between these taps is a screw with a milled head at S for raising or lowering the jet to the required position. The lime L, which is of disc form, is so placed that the flame impinges upon its circumference, and

therefore a great amount of surface is available. The lime-holder is placed through the chimney aperture after removing the chimney

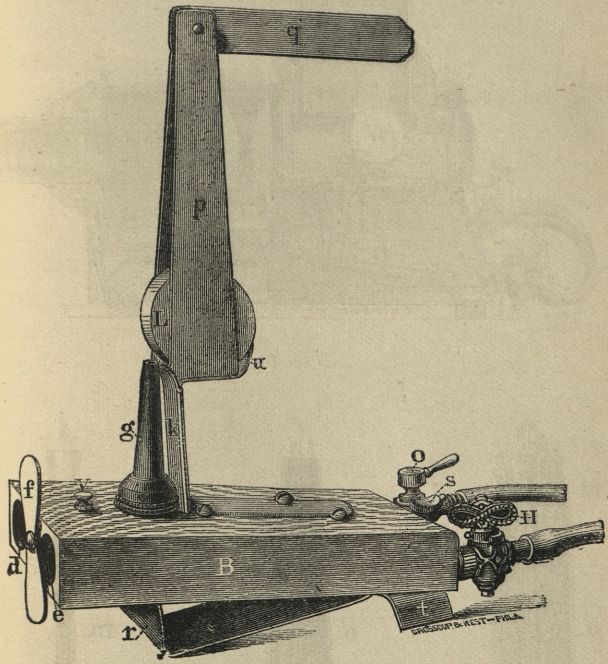


Fig. 39.

cap, and is held in position by the piece at right angles. The lime is easily turned in its cradle from behind. At D and E are two boxes in which the two jets not in use are kept, and F is a brass door for closing same. At V is a small piece of steel, mounted with brass milled head, which can be used to clean the jets when required. The whole is very accessible for cleaning,

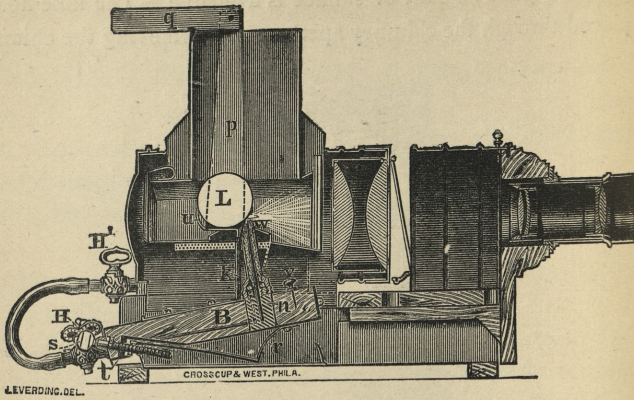


Fig. 40.

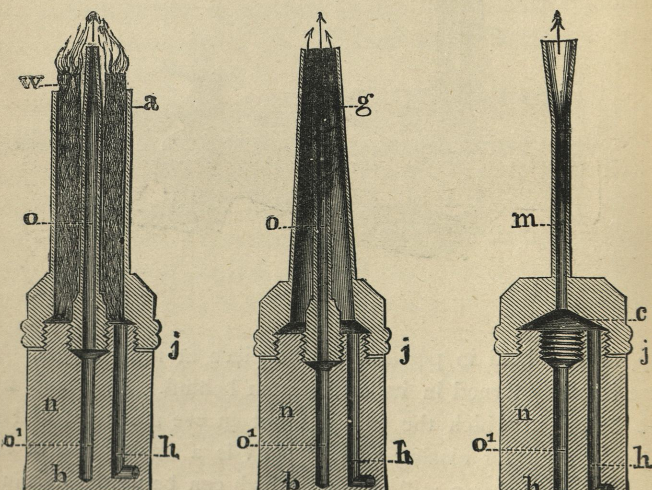


Fig. 41 *Fig.* 42. *Fig.* 43.

and capable of every adjustment. It is shown in position at Fig. 40.

The three different jets are illustrated at Figures 41, 42, 43.

Fig. 41 represents the one used for the alcohol flame or oxy-calcium jet; the wick W being fed through the hydrogen-tap from a reservoir of alcohol, with which each burner is supplied.

Fig. 42 represents the blow-through jet, and Fig. 43 the oxy-hydrogen or mixed jet, each gas being conveyed through its respective tube O or H, and is mixed in the small chamber at C previous to emerging through the nozzle M.

As before stated, it is only by the use of mixed gases that an explosion can occur, for both oxygen and hydrogen are perfectly harmless if kept to themselves, as hydrogen will not burn unless oxygen be present, and though oxygen is the supporter of combustion, it will not burn alone; therefore it is clear that so long as these gases are kept separate no danger can accrue, nor even when mixed gases are used if a pressure be maintained.

To provide against the possibility of accident when using mixed

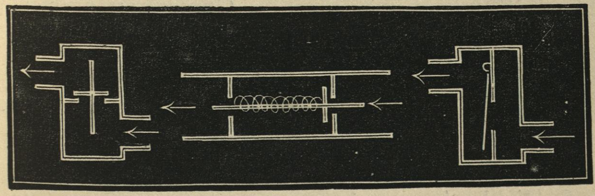


Fig. 44.

gases, various devices have been proposed, some very ingenious, and some very inefficient, with the object of preventing the flame being drawn down the supply-pipes. Layers of fine wire gauze have been introduced into the supply-tubes. This plan was found

inefficient, as an oxy-hydrogen flame could easily be made to pass through the gauze.

Mr. J. T. Taylor devised three different forms of safety valves, shown respectively at Fig. 44. It will be seen that the two outside ones are only intended to be used in the positions shown in the woodcut. The centre one is by far the best arrangement, and possesses the advantage of being used in any position, therefore it is the most approved form. It consists of a metal valve, and a fine spiral spring, so adjusted that very little force is required to open it, and remaining closed in its normal position prevents any return of gas, and also the passage of a flame impossible.

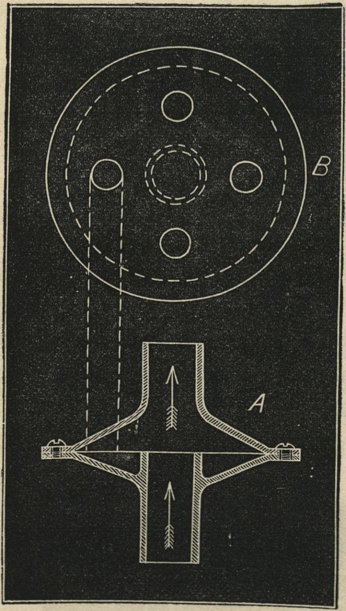


Fig. 45.

Gurney's arrangement was to pass the gas through a slight column of water under the jet; but this was not a convenient arrangement, and in many cases was not effective.

Mr. S. Highley improved upon this latter plan by an additional valve, and with his arrangement an explosion would be impossible. But even this plan was not without fault, being somewhat complicated, and the writer has often known many lanternists to shirk the use of many good things on account of the extra trouble in their adoption. He has therefore devised a valve styled a "back-

pressure valve," clearly illustrated at Fig. 45. It consists of two parts made in brass, between which is placed a thin india-rubber or oiled silk diaphragm, through which four or five holes are made as shown at B. The area of these orifices is in excess of the ingress-tube, therefore the slightest pressure entering the valve in the direction of the arrow would act upon the diaphragm so as to open the valve, and allow the gas to pass with the least possible resistance on account of the large area of diaphragm exposed to pressure.

As the valve in its normal condition is closed, nothing whatever could pass the opposite way, and the greater the pressure in an opposite direction the tighter would the valve be closed. Both india-rubber and oiled silk withstand the action of the gases moderately well; but should occasion ever require, the valve could be readily taken to pieces, and a new diaphragm be inserted in a few minutes. This valve has been subjected to most severe tests, and in no one instance has it failed to act efficiently.

PHOTOMETRY.

IN estimating or measuring light, instruments are necessary, called Photometers, the standard of comparison being a candle, defined by Act of Parliament as a sperm candle of six to the pound, and burning at the rate of 120 grains per hour. It seems unfortunate that no better standard was fixed upon, as candles, commercially, are not manufactured alike in different places, and the varying quality of the material, together with the thickness of the wicks, make serious differences in the results of experiments in various places.

There are many forms of "Photometers," the simplest being the "Rumford" or the "Bunsen." At Fig. 46 is an illustration of the former, the principle being based upon the comparison of shadows. The light to be tested should be placed at some given

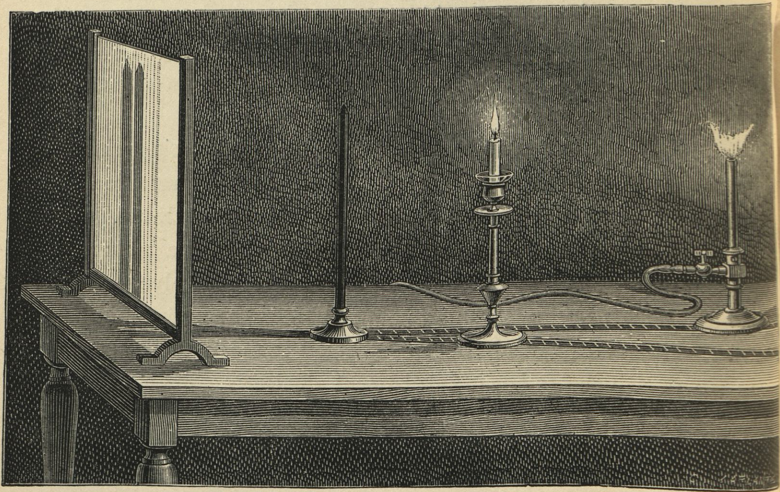


Fig. 46.

distance from the screen, which may be transparent and viewed from behind, or opaque and viewed in front. A rod is then fixed a few inches from the screen, on to which a shadow will be thrown. Now place the candle at such a distance that another shadow of equal depth is seen alongside the first one. The distance of each should be measured off, each measurement should be squared, and on dividing the greater by the lesser, the quotient will be the illuminating candle power.

"Bunsen's Photometer" consists of a white paper screen, with

a grease-spot in the centre. The light to be tested is placed at a given distance on one side of the screen, and the candle at the other, the distance being regulated so that the grease-spot appears neither lighter nor darker than the rest of the screen—in fact, is invisible from either side. The respective distances are now measured off, and their squares are proportional to the illuminating powers. In comparing lights no optical arrangements should be used, as this would seriously interfere with the results. Thus, in testing the lime light, the jet should be entirely removed from the lantern, and tested without being shown through either condenser or objective.

A series of experiments were gone into by the author, in which both "Rumford's" and "Bunsen's" Photometers were used, both kinds being adopted, so as to check the results. Below will be found the averages of several illuminating powers, as resulting from those experiments:—

Sciopticon	41.7	standard candles.
Oxy-calcium	152	" "
Safety or blow-through jet .	208	" "
Oxy-hydrogen or mixed gases	430	" "

DISSOLVING VIEWS.

DISSOLVING VIEWS were originally invented by Mr. Henry Langdon Childe, who in 1811 publicly exhibited them for the first time. The effect was produced, as now, by the employment of two lanterns, with an apparatus arranged in front of the objective lenses, whereby the light from one lantern is admitted on to the screen at the same time that the light from the

other one is obliterated. This apparatus is styled the "Dissolver," and at Fig. 47 will be seen a pair of lanterns with the same applied. It consists of a serrated plate or comb, placed in front of the objectives, and attached to a vertical bar with a rackwork and

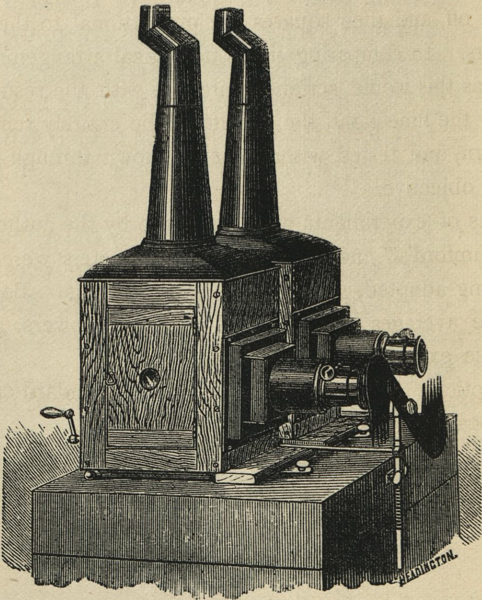


Fig. 47.

pinion; a handle at the back of the lanterns, so placed as to be accessible to the operator, gives motion to the rack and pinion, which moves the comb vertically, thereby alternately shutting out the light from each lantern. In the illustration the right-hand lantern is closed, while the left-hand one is full open, and a picture in this lantern is supposed to be projected on to the screen. Now by turning the handle, the "Dissolver" will rise, and in so

doing will gradually cover the right-hand lantern objective; at the same time it will as gradually open that of the left-hand lantern: thus one picture is caused to fade away at the same time that another one is made to appear.

The blending into each other of the pictures (with no increase or decrease of illumination) is such that the transformation, when suitable pictures are selected, is most wonderfully beautiful and fairylike.

Prior to the introduction of Mr. Childe's Dissolving Views, the lantern was considered merely as a toy, and not of educational value.

Probably the earliest employment of the Magic Lantern to educational purposes was originated by the late Richard Vaughan Yates, Esq., of Liverpool. Mr. Yates having made a tour in the Holy Land, on his return he had a number of paintings on glass executed by some of the best artists of the day, to illustrate the principal places of interest visited during his travels.

Mr. Yates, assisted by Mr. Dancer, optician, at that time of Liverpool, exhibited these views to delighted audiences. The late John Smith, Esq., one of the proprietors of the "Liverpool Mercury," was so impressed by these exhibitions, as showing the lantern's importance as an educational instrument, that he arranged an extended course of lectures on geography, to be illustrated by aid of the lantern. These lectures were delivered and illustrated by the above means in all the principal towns of the kingdom, and proved very remunerative.

The illumination of these exhibitions up to this period had been effected by means of oil lamps, which did not prove satisfactory in some of the larger rooms, and in 1837, Mr. Dancer, optician, now ot Manchester, suggested to Mr. Smith the use of the "lime light," or, as it was then styled, the "Drummond light," which at that time was in use for gas microscopes only.

The artists who painted the slides predicted that their pictures would be ruined by such a light.

The new illuminating power supplied Mr. Smith's wants admirably, and the success of these lectures at once induced Mr. James Robinson, of Liverpool, to commence in a similar line, and Mr. Dancer supplied him with an elaborate oxy-hydrogen lantern, having 9-inch condensers. The directors of the Manchester Mechanics' Institution have largely contributed to popularize the Magic Lantern as an educational instrument, and their annual exhibition proved very remunerative and attractive. To Mr. Dancer is due the credit also of having first exhibited photographs in the lantern, the first one being of the programme at the above institution. At this time Messrs. Negretti & Zambra were the sole agents for the magnificent stereoscopic slides of M. Ferrier of Paris, and a number of these slides were sent down by them to Manchester. Mr. Dancer prepared them for the lantern by dissolving away the white wax with which they were backed, and under the excellent management of Mr. E. Hutchins, the Secretary of the above institution these exhibitions justly obtained a wide celebrity, and many other public institutions throughout the kingdom were prompted to enter into a similar enterprise with more or less success.

Now that the introduction of photography in connection with the Magic Lantern had become instituted, its value as an educational instrument became more apparent, for although many of the hand-painted slides were very beautiful and artistically produced, a single picture costing in some instances as much as twenty guineas, yet the artist, however eminent, can never aspire to the accuracy of photography in minute detail.

A climax would now seem to have been reached, when Mr. Dancer conceived the idea of a dissolving tap, having six ways. The object of this tap was to shut off the gases from each lantern

alternately, thereby dispensing with the mechanical dissolver already described. The first of these was made by Mr. Dancer for the Manchester Mechanics' Institution, which, on being tried, surpassed in result all expectation, for not only was the dissolving better, but about 50 per cent. of the gas was saved. It has proved equally applicable with the mixed jet, the safety blow-through, and the oxy-calcium lime light, and has since its introduction been modified in various ways, with pretty much the same result.

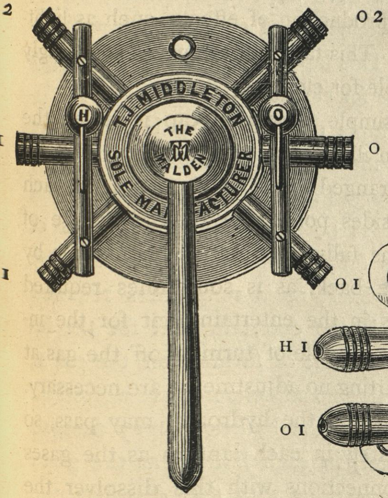


Fig. 48.

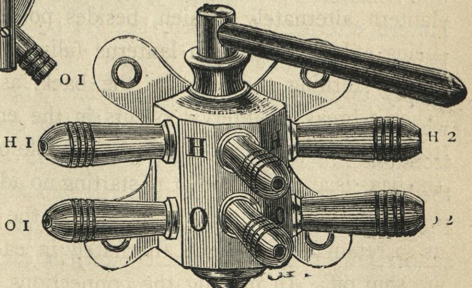


Fig. 49.

The "Malden" Dissolving Tap, shown at Fig. 48, was designed by B. J. Malden, Esq., F.R.G.S., who was for many years connected with the Royal Polytechnic Institution. As will be seen, his tap consists of a single plug, which has two cavities cut in it in such positions that when the lever is straight down as shown, and the gases entering at their respective branches indicated by O and H, the passage is clear to both lanterns. O^{1} and H^{2} must be connected to the jet of one lantern, and O^{2} and H^{1} to the other. When the lever is drawn to the right hand, the lantern to

which is connected O^1 and H^2 will be illuminated, and the other one will receive no supply of gas through the plug; but in order to retain a small light as the gases are alternately shut off, small stop-cocks are provided. These can be adjusted at the commencement of an exhibition to the size of light required. It is in many cases advantageous to have both lanterns fully illuminated at the same time for the production of effects, such as lightning, the bursting of shells, etc. This tap altogether is exceedingly well finished, and very accessible for cleaning.

Another very effective and simple dissolving tap is styled the "Polytechnic Gas-Dissolver," an illustration of which is at Fig. 49, and consists of a single plug, arranged to cut off the gas from each lantern alternately; which, besides possessing the advantage of being able to have both lanterns fully illuminated at one time by simply turning the lever to the back, as is sometimes required when a break or interval occurs in the entertainment for the introduction of a song. Thus the trouble of turning off the gas at the bags is avoided, and at re-starting no adjustments are necessary. Provision is made in the plug so that the hydrogen may pass, so as to retain a faint light alternately in each lantern as the gases are shut off. In making the connections with this dissolver, the gases are to be introduced at the branches indicated, O and H, and the branches marked O^1 and H^1 must be connected with the jets of one lantern, and those marked O^2 and H^2 must be connected with the jets of the other. Dissolving taps, however well made, require cleaning periodically, and before giving an entertainment they should be taken to pieces, the pipes, plugs, and nozzles thoroughly cleaned and smeared over with a trace of fine olive oil. Burnt india-rubber has been recommended as a lubricant for the plugs of such apparatus as come in contact with oxygen, but this seems merely to be an excuse for a badly-fitting plug.

DANCER'S LANTERN.

THIS lantern is one of the most perfect and high-class lanterns of the present day. Mr. Dancer, of Manchester, is an optician of high standing, and a gentleman to whom the scientific world is indebted for many valuable inventions. He was the first to produce micro-photographs. He was the first to apply the lime

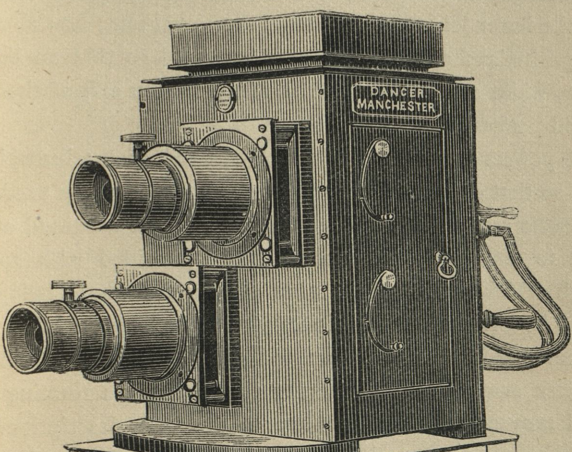


Fig. 50.

light to the lantern, and also the first who exhibited photographic transparencies in the lantern. He is also the inventor of the dissolving tap, and was the first to apply achromatic powers to the lantern, and also to use house gas direct from the main, with oxygen, to produce the lime light. From this we may conclude

that he has devoted much time and attention to the development of the Lantern.

In his Lantern illustrated at Fig. 50, one body combines in it the two optical systems, which are placed diagonally as shown. By this arrangement the axes are brought as near to each other as possible, still allowing ample room for the manipulation of the slides either horizontally or vertically, the latter being convenient for effects, such as balloon ascents, etc. The discs are brought concentric on the screen, by an adjusting screw brought through and arranged at the back of the lantern. The heat emanating from the lower jet in no way affects the upper one; no tall chimney is requisite, and a neat flat top is arranged so that no light can escape, while ample provision is made for the exit of the heated air, and perfect ventilation is secured.

The powers are of the highest class, fixed upon telescopic brass tubes, so that objectives of long or short focus can be used. The condensers are of the best construction, and are mounted with due regard to expansion, the mounts being provided with apertures through which any moisture may escape, the whole being fitted into the lantern and secured in its place by a bayonet joint. When required, this lantern can be fitted with an excellent and novel clockwork arrangement for giving to the limes a rotating also a vertical movement. The jets are of the best description, fitted with platinum points, and arranged either to burn mixed gases, as a safety blow-through, or for oxy-calcium. A dissolving tap is fixed at the back, with adjusting screws to regulate the supply of hydrogen in each lantern for maintaining a light when the oxygen is turned off, and the whole of the adjustments so arranged as to be within easy access to the operator, thus making a most complete and self-contained instrument.

THE MALDEN BI-UNIAL LANTERN.

THIS lantern, illustrated at Fig. 51, combines two lanterns in one, having their optical systems placed one over the other. This form of Dissolving View Lantern seems the one most in general use at the present time.

The bodies are constructed of well-seasoned mahogany, with sheet-iron linings, between which and the body there is a cavity forming an air-passage, which, being perforated at the bottom, together with a neat chimney, creates perfect ventilation. The jets and dissolving tap are of the best construction, and the optical systems of approved form, the condensers and their mounts being secured into their places, thus giving safety while travelling. The achromatic objectives are arranged so that they can be made of different focal lengths, and are mounted in telescopic brass fronts. The discs are brought concentric on the screen by means of milled-headed screws placed in front. The whole apparatus is of the best workmanship throughout, and in its form possesses great advantages over two distinct lanterns, the whole being under the control of a single operator, without the necessity of moving from side to side. It is very light and portable, and is arranged with a packing-box, in which all can be placed for travelling, and which forms a solid stand, upon which the lanterns can be worked. Separate compartments being provided for the slides, no liability of derangement need be feared. When covered with drapery of an approved colour, and the lantern placed on the top, the whole forms a handsome piece of apparatus. This instrument has been used to cover the large disc at the Royal Polytechnic Institution and others with great success.

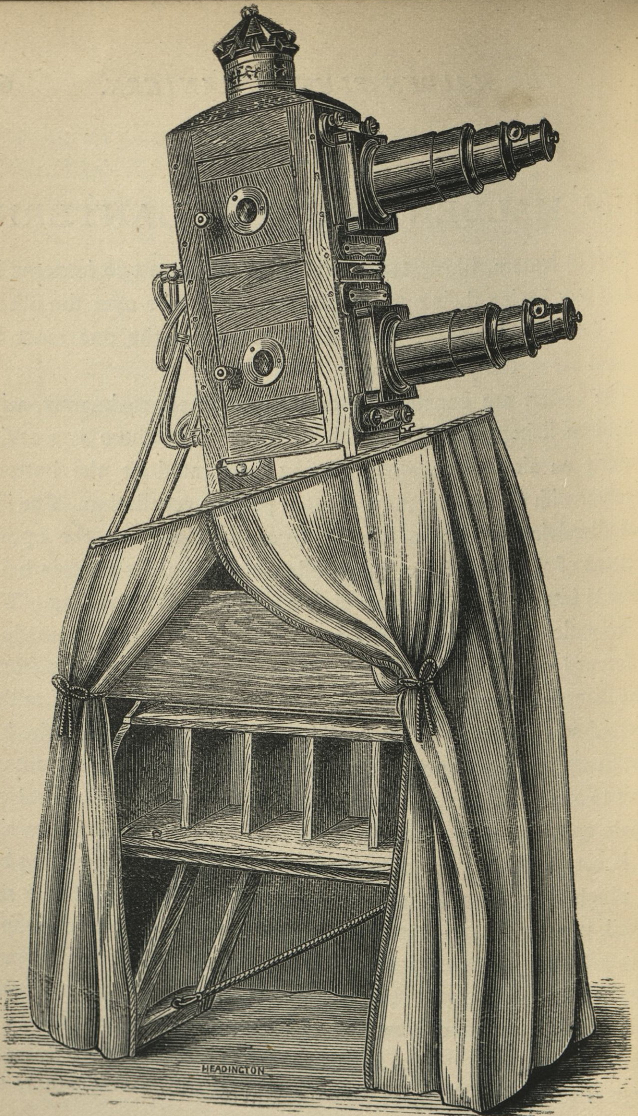
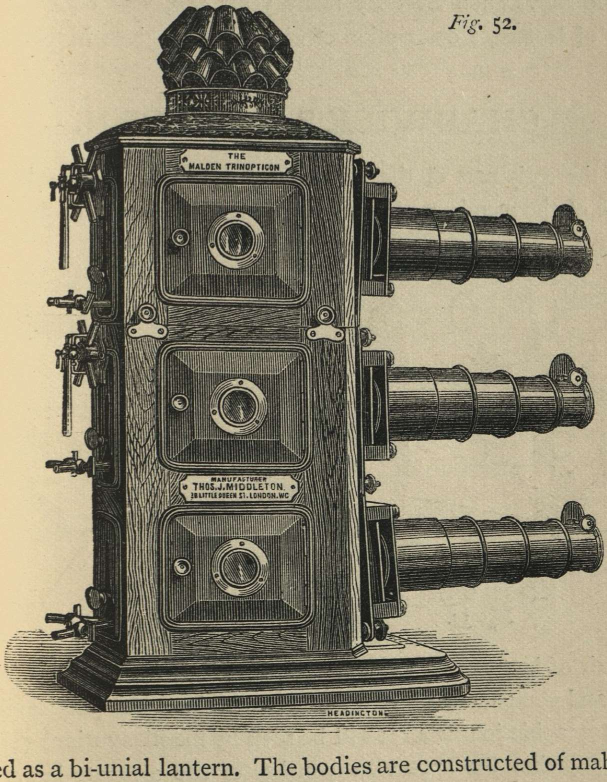


Fig. 51.

The "Malden Trinopticon" is similar in construction to the Malden Bi-unial Lantern, but with the addition of a third lantern placed on the top, as shown in Fig. 52, which can be removed at will and used as a single lantern, also the lower portion can be

Fig. 52.



used as a bi-unial lantern. The bodies are constructed of mahogany, with three doors on each side, so that the operator may manipulate the lights from either side. These doors have each a small blue glass window inserted. The jets and optical systems are similar

in construction and arrangement to the bi-unial lantern, a packing-box also being supplied, which forms a stand when the lanterns are in use.

The advantage of a third lantern for effects was first suggested by the Rev. Canon Beechey many years ago, who constructed a form of lantern, a description of which will be given hereafter.

CHADWICK'S LANTERN.

In the early part of the year 1878 the author introduced to the notice of the members of the Manchester Photographic Society a

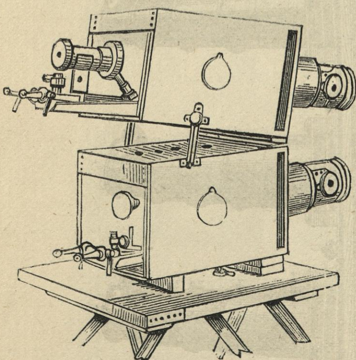


Fig. 53.

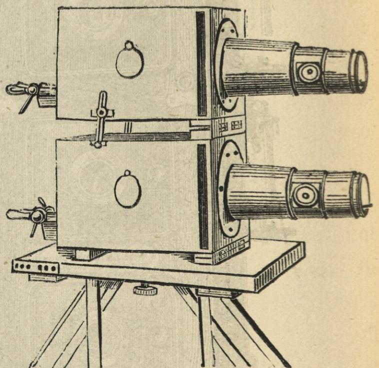


Fig. 54.

small pair of lanterns, which were admired for their neatness, simplicity, and compactness. A description of them was published in the photographic journals. It will be seen by the illustrations (Figs. 53 and 54) that the apparatus consists of two separate lanterns, placed one over the other. A hinged piece attached to the bottom of each lantern forms a means of coupling the two, and also allows of the adjustment necessary to bring the discs concentric on the

screen. When once adjusted, they are kept in position by two slotted bars and milled-headed screws, as shown in the illustrations. The hinged piece on the bottom lantern also admits of any necessary adjustment, and also forms a means of securing the whole to a table, stand, or tripod top. The bodies are made of mahogany, the inside dimensions being 5 inches square, which are lined with sheet tin (allowing an air space between the lining and the body), and so perforated as to prevent the emission of light, while securing perfect ventilation. The conical fronts holding the objectives are attached to the bodies by screws, the holes in the flanges of the fronts being slotted, so that they may be easily detached, and if required can be packed inside the lanterns. The apertures for the pictures are made of the standard width, in which are placed registering carriers, a description of which is given later. The jets are of the ordinary safety blow-through kind, the nozzles of which can be removed for cleaning. The lime-holders are arranged for the disc form of lime, $1\frac{3}{4}$ inches in diameter, and are perfectly adjustable, easily removable from their spring clip support, and are manipulated by wood discs placed at their outer ends. The condensers are $3\frac{1}{2}$ inches in diameter, and secured by a bayonet joint arranged to a flange fixed inside the bodies. The objectives are fitted into telescopic brass tubes, with extra rack and pinion motion for fine adjustments in focussing. Every part of the nozzles oı the jets can be viewed from the back by reflection from the condensers, and the shutters at the side cover small windows of blue glass, through which the lights can be seen, also the limes. When necessary, a third lantern, an exact duplicate of the other two, can be placed on the top, or the two lanterns may be used side by side or singly. With these lanterns the author has shown large-size discs to the greatest perfection. Their extreme portability and efficiency, together with their inexpensive character, have prompted him to

recommend them to those amateurs who may wish to construct a lantern personally for their own use.

BEECHEY'S LANTERN.

Up to the present time dissolving views have been treated of as being produced by two lanterns, or with one lantern arranged with two separate lights. An idea for producing the above effect with

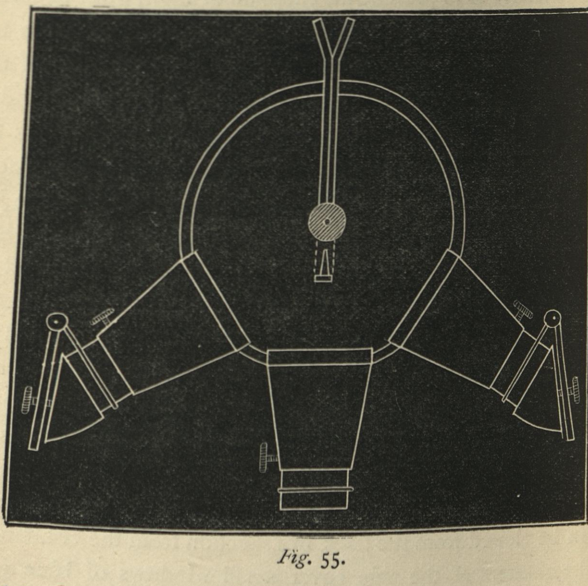


Fig. 55.

one light only, emanated from the Rev. Canon Beechey, who some thirty years ago had a lantern constructed in which only one light was used to illuminate three distinct optical systems, and for the purpose of producing dissolving views and other dioramic effects. This lantern was first exhibited at the Exhibition of 1851, and is here illustrated at Fig. 55.

It consists, as shown in the diagram, of three separate optical systems emanating from one body, with prisms placed at the extremities of the side systems, which were placed at such angles that the discs from all three were concentric on the screen. The first illuminating power used was the oxy-hydrogen lime light, the cylinder form of lime being used, and which was supported upon a pin, this pin being fixed central with all three condensers. An unequal light was the result, the side systems receiving less than the centre one. As it was the inventor's intention not only to produce dissolving views, but also to have all three systems in operation at the same time when required for effects, etc., he therefore discarded the cylinder form of lime and substituted the spherical, which was suspended by a platinum wire over the flame of a fountain oil lamp, through the centre of which passed a gentle stream of oxygen. The whole of the lower portion of the lime was thus rendered luminously incandescent, and the rays of light collected by each system thus equalized. The oxygen nozzle being of large size, little pressure was needed, and therefore the lime was not liable to split, as if a small nozzle and heavy pressures had been used. Although this oxy-calcium light was much inferior to oxy-hydrogen, it proved very successful for small-sized discs. A very perfect mechanical dissolver was attached, and the whole arrangement was so simple and unique that we cannot but express surprise that the principle has so long remained in *statu quo*.

This same idea of dissolving with one light has been adopted by M. Duboscq, of Paris, substituting the electric for the lime light. In Duboscq's apparatus, both sets oi lenses were placed as close together as possible with convenience, and parallel to each other; a concave reflector being arranged to throw the light to each condenser alternately, while a very simple sliding dissolver opened and closed the objectives.

KEEVIL'S LANTERN.

Last year another form of dissolving lantern made its appearance, based upon the original idea of Canon Beechey (namely, dissolving with one light), and which was styled "Keevil's Patent Newtonian Lantern," illustrations of which are shown at Figs. 56 and 57. It is duplex in form, being fitted with one optical system, projecting in front, shown at A, and another projecting from one side, as shown at B. The light through the system A is transmitted on to the screen directly, in the usual way. At the extremity of the system B is fixed a prismatic lens, by which means a disc can be projected on to the screen, central with the one from A. The oxy-hydrogen jet is arranged on a pivot, which is a fixture in the bottom of the lantern, the centre of rotation being as near the outside surface of the lime cylinder as possible; and by rotating the burner through about a quarter of a circle, the light is brought central with each condenser alternately, and simultaneously the mechanical dissolver (C C) opens and closes the

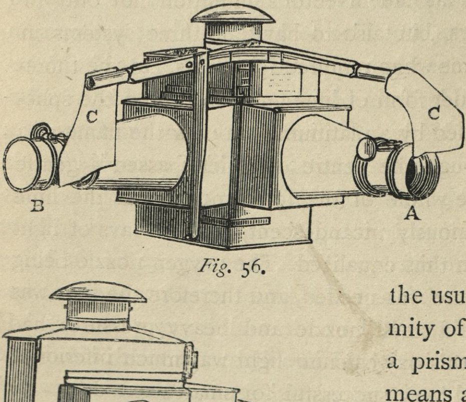


Fig. 56.

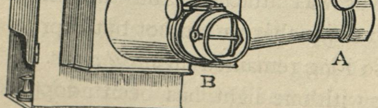


Fig. 57.

objectives. To compensate for any loss of light occasioned by the use of the prism, the condenser of this system is made somewhat shorter in focus than the other one, evenness of illumination being thereby secured. Both objectives are made achromatic, and the definition of the one to which the prism is attached is in no way inferior to the ordinary one. The jets never require adjustment, as every lantern is put to a practical test before being sent out; the best position for the jet being thereby obtained, further adjustment becomes unnecessary. The dissolving apparatus is adjustable and very efficient. The conical fronts are easily detached, and if required it can be used as a single lantern.

Its small dimensions are much in its favour, the whole packing into a small box, easily carried in the hand. These desiderata are certain to make it a favourite with those who wish for an apparatus of extreme portability.

THE OPAQUE LANTERN.

MAGIC Lantern pictures are called Transparencies because they are shown by light transmitted through them; but a very wide range of opaque subjects can be exhibited upon the screen, and made highly interesting, by an instrument introduced first in a practical form by Messrs. Chadburn and Sons, opticians, Liverpool, in which photographs, cartes-de-visite, engravings, drawings, and other opaque objects, such as minerals, crystals, shells, plaster casts, medals, cameos, coins, small flowers, watches in motion, the human hand and face, and an infinite variety of subjects, may be exhibited with their natural colours and shades.

Its construction (see Fig. 58) consists of a lantern box, in which is fixed a pillar to which the lime-cylinder is attached, and behind

it is a large silvered reflector, accessible for adjustment, which can be raised or lowered, moved backwards or forwards; the light it receives being thrown upon the condenser, and thereby concentrated upon the picture or object placed in the sliding door of the angular box which joins up to the square compartment. The illuminated picture or object is then received by the achromatic objective, and projected upon the screen. The angular compartment can be detached and replaced with ordinary lantern fronts, and direct light with transparent pictures can be used. The half of an orange, if squeezed and placed in this lantern, has a particularly grotesque effect.

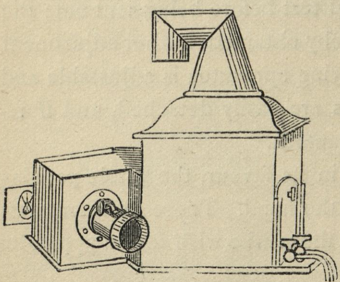


Fig. 58.

A convenient adaptation to the ordinary lantern has been designed and manufactured for exhibiting opaque objects, styled the "Aphengescope." These are made suitable for both single and double lanterns, the latter one giving the better results. It may be described as a box hexagonal in shape, two sides of which are provided with holes to receive the lights from the two lanterns, the objectives having been removed. On an intermediate side, between those in which the holes are made, is fixed an objective, and at the side opposite this objective the objects to be shown are placed; thus it will be noticed that the lanterns themseves are fixed with their backs opposite the screen, the light rom both being united and concentrated to illuminate the object. On account of the great loss of light by reflection, large exhibitions with this adaptation should not be attempted.

STAND FOR THE LANTERN.

A USEFUL and convenient Stand for the Lantern is illustrated at Fig. 59. It is manufactured by Mr. Oakley, of 202 Grange Road, Bermondsey, London, and consists of a tripod

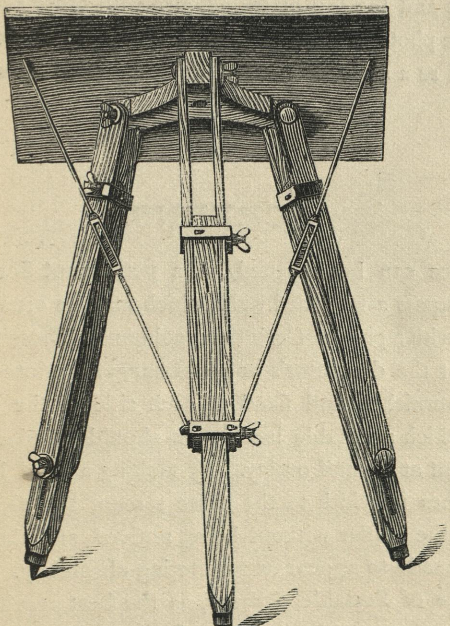


Fig. 59.

made of either ash or oak, upon which is fixed a board to which the lantern is attached. It possesses great steadiness, and is capable of adjustment to work at any height or angle, to suit the

operator. In many instances it is desirable to have the lantern elevated to a considerable height from the floor, so as to bring the centre of the lantern in line with the centre of the screen. Thus, in showing a picture 12 feet in diameter, the bottom of which should not be less than 2 feet from the ground, the centres of the lantern would require to be 8 feet from the floor. This tripod is made when required with a ball-and-socket joint, placed between the flat top and the top of tripod, also with other accessories suitable for the photographer in supporting large cameras. It may also be adapted as a stand for supporting large telescopes.

SCREENS.

IF a place can be assigned for a permanent Screen, nothing can surpass a whitened wall, which may be ornamented with drapery, or with a pair of Corinthian columns. These latter can be purchased at the decorator's or paper-hanger's, printed in colour; and when varnished and fixed at each side of the screen, over the top of which a suitable inscription should be placed, form an embellishment at a small outlay. By making a dead black border of some inches in width to the white screen, the pictures shown may overlap the border without being noticed, and thus every picture may be made to appear as registering absolutely.

In the case of Portable Screens, as the best results are to be derived from opaque ones, screens of this class may be obtained up to 10 feet square, made of cloth, faced with white paper having an ornamental border, the whole mounted upon a roller. This is a very convenient form, and is easy to erect; but beyond the above dimensions they are altogether out of the range of portability.

Those next in quality are of linen; these also can be had up to 10 feet square, having no seams. As it is very objectionable to have a seam running down the centre of a screen, if a large one is required, it should be made by joining two pieces outside one wide width, so that the centre portion is free from piecings. A method adopted by the author for suspending linen screens of large dimensions in school-rooms, is to fix iron staples in the wall near to the ceiling, and also near to the floor. The screen being provided all round its edges with loops of tape, a sash-cord of

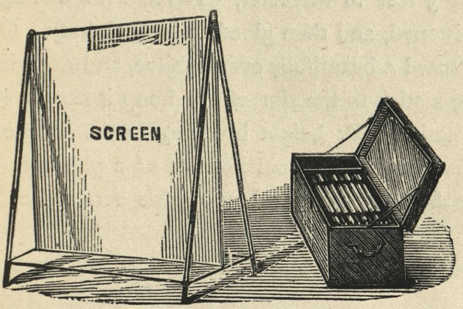


Fig. 60.

suitable strength is threaded through the loops and also through the staples, whereby the whole is stretched perfectly tight and even. A length of fringe attached to the top, with a little drapery hanging down either side, gives a neat appearance without much trouble or cost.

A convenient form of portable screen up to 10 feet is shown at Fig. 60. The frame is put together in the manner of a fishing-rod, and can be erected at private entertainments, without having to disturb furniture, etc., in an incredibly short time. It is, moreover, capable of being packed in a very small compass; another advantage being that it can be used as a Transparent Screen when

occasion requires, the audience being placed on the opposite side to the lantern; but it should be known that by adopting this plan the result is never so good as with an opaque screen.

Transparent screens can be made of thin cotton sheeting, or, what is still better, of muslin. Before using they should be well wet with water; best applied after the screen is erected, by means of a garden syringe. This wetting makes the surface more homogeneous and transparent. A neat screen for exhibiting microscopic objects was constructed by the author, out of a child's wooden hoop about 3 feet in diameter, covered with tracing-paper, previously moistened, and then glued to its periphery. On becoming dry, it presented a beautifully even surface, and as tight as a drum. By screwing a stick to the rim of the hoop it can be held in position, and regulated for height by tying to the back of a chair, or it may be fixed in the bottom portion of a photographer's head-rest stand. Statuary exhibited upon this screen has a charming effect.

LANTERN SLIDES.

THE production of Photographic Magic Lantern Slides has been taken up, commercially, by some very enterprising firms in England, France, and America, the result being that complete series of views, at wonderfully low prices, are to be obtained, not only of our dear old country, but also of our much-prized India, the land of the Pharaohs, of the Holy Land, of the Alpine scenes of Switzerland, of the ruins of sunny Italy, of the bygone splendour and greatness of Spain, of the natural wonders of the Far West, of the Polar regions, of the Tropics; and even the bowels of the earth

have been photographed, as have also the fantastic and ever-changing forms of aërial grandeur; whilst portraits of the sun, with the vast protuberance surrounding his edge, and the dark spots which travel across his face, together with eclipses, our satellite in all her phases, and the spectra of other heavenly bodies, though yet so far, are brought so near; and the most minute details of insects and objects invisible to the unaided eye are produced in magnified dimensions with that correctness to which no living artist can aspire. On looking at a photograph, we feel sure that we have a faithful representation of the subject, for the photographer has neither the power to add nor to detract from his subject. He must, therefore, choose his point of sight with the skill which denotes the difference between a mere photographer and one who combines art with his profession.

The photographic transparencies in carbon, and known as the "Woodbury Lantern Slides," are among the finest ever produced. The process of their production admits of any colour, perhaps none more beautiful than the warm chocolate, for which these slides have obtained a world-wide reputation. They are printed from some of the choicest negatives of the most eminent photographic artists in the world: thus almost every slide in the long list published by the Sciopticon Company may be relied upon as a photographic gem. The shadows and darker portions are of a more transparent colour than in slides of which silver forms the deposit; thus more light is allowed to pass through, and a more brilliant picture obtained on the screen. These slides are made 4¼ inches long by 3¼ deep, with a neat mount bearing the name of the subject. The apertures of the mounts, in some cases, are round, in others cushion-shaped, the latter being larger and showing more picture than any other photographic lantern slide; condensers of 4 inches being required to cover them.

The productions of Mr. F. York, of 87 Lancaster Road, Notting Hill, London, merit special praise. This gentleman has devoted himself more to the production of photographs for the lantern than perhaps any other man in the world. The pictures of the animals in the collection of the Royal Zoological Society are really wonderful. The architectural views of London, and the more recent pictures of Paris and its Exhibition, are characteristic of the greatest ability as an artist and as an experienced photographer. Mr. York's slides are produced by the wet collodion process, and toned with platinum, and therefore may be relied upon for permanency. They are of uniform size, 3¼ inches square, with circular mounts, having an aperture 2⅞ inches in diameter. In the opinion of the author the circular-shaped aperture is most preferable for a lantern slide, for not only is the picture in better focus at centre and sides, but smaller condensers are required to cover them, therefore better light is obtained, condensers having a diameter of 3½ inches being ample for these slides. Recently Mr. York has adopted the plan of printing his slides up to the edges, thus giving the opportunity to those who would prefer to substitute any other shape of mount, square, cushion-shaped, or dome. On the edge of each slide is a printed label, bearing the title of the picture, and rendering the whole complete.

Mr. Wilson, of Aberdeen, also Mr. Valentine, of Dundee, are producers of lantern transparencies which rank among the highest class. These are principally of Scotch scenery, and the wet collodion process being adopted in the production of the negatives, wonderful atmospheric effects are obtained. Sometimes the introduction of figures, artistically arranged, lends a charm to the natural beauty not often excelled.

The French slides, especially those of MM. Ferrier, Son & Soulier, of Paris, have long held a reputation for excellence, and as for

choice of subject, their catalogue contains more than that of any other firm known. Although stereoscopic views have long been their specialty, lantern slides have also received their consideration, and in former days eclipsed all others.

These transparencies were produced on albumen dry plates, the exact formula of their preparation being kept a secret. It is supposed that they were toned with sulphur, which, although it produces a most agreeable tone, is not always permanent. Photographs treated in this manner have been known to fade in a moderately short time, and leave behind but a shadow of their former beauty. The present firm have produced of late years many excellent lantern slides; and as stereoscopic transparencies, it is much to be deplored, have not been so much in request as formerly, perhaps lantern slides may have occupied more of their attention.

A good stereoscopic slide does not always make a good lantern slide, as the latter usually requires less printing than is suitable for the stereoscope; and though French stereoscopic slides are unsurpassed, their lantern slides are not to be compared with the best English productions.

PRODUCTION OF PHOTOGRAPHIC SLIDES.

ALTHOUGH there are many lanternists who are also photographers, there are, perhaps, many who dread entering into that art which brings up visions of soiled fingers, spoiled clothes, dark rooms filled with a mass ot apparatus and bottles enough to fill a museum or chemist's shop, and unlimited expenditure. To such readers it may be as well to give a few details on

the Production of Photographic Slides, so as to banish from their minds all these ideas. Nowadays photography need not be made the expensive, laborious, and tedious art of the past. Modern improvements have placed it in the power of almost every tourist to become a photographer, and for the production of lantern transparencies the whole apparatus, including pocket camera, chemicals, dry plates, etc., may be kept in a box or cupboard, no dark room being necessary, as all operations requiring the exclusion of daylight can be performed in the evening. However, as this treatise does not admit of a full description of photography, we will suppose the reader to have acquired some knowledge of the art from some of the many excellent modern works published on the subject, and merely give an outline of a lengthened experience in the production of lantern transparencies. These may be produced in several ways, by wet collodion, dry collodion, albumen or gelatine dry plates, and also by the carbon process.

Respecting the Wet Collodion Process, the negative to be copied should be soft and full of detail; it may be of any size, those of large size, say 12 by 10 inches, being as convenient as stereoscopic size. A camera and lens of ordinary construction will answer the requirements. The negative may be fixed in a window, with a sheet of white paper placed on a board, adjustable to the proper angle so as to reflect a uniform light on to the negative, and unless the negative be very intense, all diffused light should be excluded from the front. A good bromo-iodized collodion should be used, which is better for being old and ripe, with the addition of two grains of bromide of cadmium to the ounce, this latter adding much to the colour of the transparency. An ordinary silver bath should be employed, made decidedly acid with a drop or two of glacial acetic acid. Great care must be exercised in focussing, and a small stop should be inserted in the lens.

The ordinary wet collodion developer should be used, and will answer admirably, and if the exposure be correctly timed, the development should be slow and even, and toning rendered unnecessary. Fixing by hyposulphate of soda is preferred to cyanide of potassium. Should toning be required, chloride of copper in a weak solution, flooded over the plate, and afterwards intensified with pyrogallic acid and silver, gives a good result. Gold or platinum may also be used, but the use of sulphur or mercury in any form should be avoided. When dry, the transparency may be mounted without varnishing; but if a good clear coat of transparent varnish can be applied, without streaks, the brilliancy will be improved: however, as this is a part where many amateurs fail, a thin coating of albumen may be substituted.

For the above process a dark room is indispensable for development, and daylight for exposure. For those who have not the daytime to devote to the subject, dry processes offer better facilities. To enter on a description of all the various dry processes by which transparencies may be produced would in itself fill a volume, so we must content ourselves with two of the best.

The Dry Process is certainly to be preferred by the amateur, as the whole of the operations—printing, preparing plates, and developing—can be performed during the evening, no dark room being necessary. It is important to have a non-actinic light when making transparencies by this method, as the merest trace of "fog" caused by too much light would materially affect the result.

If gaslight be employed, it should be transmitted through ruby glass, or an ordinary candle protected by a non-actinic shade answers all requirements. A good shade for the purpose is made from a long hock-bottle, the bottom being cut out, also about two inches off the neck.

The Tannin Process.—In this process a substratum is neces-

sary to prevent the film from slipping off the plate during development. The following formula may be used without the necessity of polishing the plates; these, after being well washed under a tap, should be slightly drained, and while still wet flowed over with

Albumen (white of egg)	1 ounce.
Water	1 pint.
Liquid ammonia	15 drops.

This must be well shaken, either by means of an egg-beater, or in a bottle with some broken glass, and must be well filtered previous to using. After drying over a hot-water plate or before the fire, and allowed to cool, the plates are ready to receive the collodion, almost any good sample of which will do, preferably rather thick. Use an ordinary 45-grain silver bath, rather acid. After exciting the plate, wash well under a tap, and while wet apply the preservative solution, consisting of

Tannin	15 grains
Water	1 ounce.
Sugar	5 grains.

This must be fresh mixed and well filtered.

The first application should be cast away, and a second applied. Now place in the drying-rack. The exposure is made by placing the plate *close* against a negative, the two film sides being in contact, any ordinary pressure printing-frame being used. The time of exposure varies according to the density of the negative, and the distance and nature of the light. However, with an ordinary negative and placed some 6 inches away from the flame of an ordinary gas-burner, some 20 to 60 seconds will be required.

The development must be conducted in an equally non-actinic light to the preparation. First moisten the film by flowing over it a solution of alcohol and water in equal portions, now wash well, and the developing solution may be applied.

Pyrogallic acid	3 grains	mixed fresh.
Water	1 ounce	

This will soon cause the image to appear if the exposure has been properly timed; and when sufficient detail is manifest re-develop with same solution, with the addition of a few drops

Citric acid	30 grains,
Nitrate of silver	20 grains,
Water	1 ounce.

This will soon bring the picture to the necessary depth. It should now be washed and fixed in

Hyposulphate of soda	1 ounce,
Water	6 ounces,

when, after further washing, the picture is finished, and should be of a good warm tone. If necessary, it may be toned with a weak solution of chloride of gold.

The Modified Albumen Process.—By this process the best possible results are obtainable. Take a good bromo-iodized collodion, which must be old and ripe, and in such condition that as soon as it is set it may be written upon with a pen without tearing the film. After coating the plate, when set it must be immersed in water for a few minutes, and then well washed under a gentle stream from a tap. Now coat with albumen as follows :—

Albumen (from fresh eggs)	10 ounces,
Acetic acid	1½ drams.

Previous to mixing, the albumen should be beaten into a froth. Stir well with a glass rod, and allow to stand for twelve hours, then strain through muslin or sponge, and add 40 drops of strong liquid ammonia. In 6 drams of water dissolve 60 grains of iodide of ammonium and 10 grains of bromide of ammonium. Now add this solution to the filtered albumen, allow this to soak into the film for a minute or two, then set it to drain, and dry in a warm

place. To excite, the plate must be allowed to remain forty seconds or not more than a minute in a bath made as follows:—

Nitrate of silver	1 ounce.
Distilled water	8 ounces.
Acetic acid	2 ounces.

Now rinse the plate well under a tap for one or two minutes, and set aside to dry. When dry, the back of the plate must be coated with burnt sienna finely ground, with a little gum-water added.

Exposure.—From five seconds to five minutes, depending upon the intensity of the negative and the quality of the light.

Development.—After removing from the printing-frame, rinse the plate under the tap and clear away the backing, best done with a piece of spongy india-rubber. The development is best conducted in a flat dish, which may be made of a piece of ribbed glass and a well-varnished wooden frame, and need not be much larger than the plate itself.

P	Pyrogallic acid	60 grains.
	Glacial acetic acid	2 ounces.
	Water	20 ounces.
	Citric acid	10 grains.
S	Nitrate of silver	20 grains.
	Water	1 ounce.

Take of solution P sufficient to cover the plate, and warm it in a beaker to about 140 degrees Fahrenheit; pour this over the plate, keeping it in motion for about a minute, then add three drops of solution S, still keeping the plate in motion. In a short time the shadows will begin to appear: as soon as they are visible by transmitted light, wash well, and gently rub and polish well the film with a tuft of cotton wool. Now proceed with P moderately hot, and add a few drops of S. So soon as the required density is

attained, wash well and again polish with cotton wool. Fix in

Hyposulphate of soda	16 ounces,
Water	1 pint,

to which must be added

Chloride of gold	4 grains,
Water	2 ounces.

The plate must remain in the fixing solution fifteen to twenty minutes, being rocked occasionally, and when removed, well washed.

The most important condition to the success of this process is to have the collodion right, and although the iodides and bromides are washed out, it must not be supposed that plain uniodized collodion will answer the purpose. The plate after being excited should present an uniform slight blue tinge: if of a patchy or mottled appearance, the collodion is too horny. No varnishing will be required.

CARBON TRANSPARENCIES.

PERHAPS no process suits the requirements of the amateur better than the Carbon Process for the production of Lantern Transparencies. A special tissue for this purpose is prepared by the Autotype Company, of a dense warm black. It may be had either sensitized or unsensitized, and in the latter state will keep for an almost indefinite period. The method of sensitizing is as follows:—

A solution of bichromate of potash is made by dissolving one part of this salt in twenty to thirty parts of water. This is poured into a tin dish, and the tissue *immersed*, face downwards, until it becomes perfectly pliable (care being taken to exclude any air-

bubbles), which will generally take thirty or forty seconds, but in winter as much as two minutes may be requisite. In summer it is sometimes requisite to keep a piece of ice in one corner of the tin dish. The tissue on being removed is placed face downwards on a sheet of glass, which may be previously wetted with sensitizer. A squeegee is now passed over the back to remove all excess of solution taken up by the paper. On removing from the glass plate, the tissue will be found to present an uniformly clear surface. It must now be hung up to dry. As much depends upon the drying, amateurs whose requirements are small would do well to purchase the tissue ready sensitized.

The glass plates on which the transparency is to rest should be prepared by coating with

Gelatine	1 ounce.
Water	10 ounces.
Chrome alum	10 grains.

This must be caused to flow over like collodion, and, if necessary, be guided to the edges of the plate by a glass rod. The plates may now be reared up, and when dry are ready for use.

These will keep any length of time, so they may be prepared beforehand.

To Print.—A thin black paper mask must be placed upon the negative, the aperture in which being a little less than the glass plate, and to include as much of the picture as wished. The object of this mask is to procure what is termed a "safe-edge." The sensitized tissue, already cut to the size, is now laid upon the masked negative and printed in a pressure-frame. A little longer exposure will be usually required than would be necessary with sensitized albumenized paper. The exposed tissue is now removed, and immersed face down in a dish of cold water. It will immediately curl up, but will in a few seconds lie perfectly flat in the water. At this

stage slip one of the prepared glasses into the dish, and bring its gelatinized surface directly under the tissue; draw the two out of the water together, and apply the squeegee to the back. As many as are printed may be treated in a similar manner, and placed one on the top of the other to keep them flat. The underneath one may now be developed by placing it in water of the temperature of 80 to 90 degrees Fahrenheit, and shortly the paper forming the backing to the tissue will curl away. A dark slimy mass will now be perceived on the glass plate, and by gently moving the plate in the warm water the soluble portions will clear away, leaving the insoluble portions attached to the glass plate.

Should the transparency appear too light, deficient in half-tone, and without depth in the shadows, it is a sign of under-exposure; should it be over-exposed, it will be dark and indistinct, and the gelatine, of which the tissue is formed, difficult to dissolve away, in which case increase the temperature of the water. The remedy for under or over-exposure is decrease or increase in temperature of the water, warmer water being necessary for over-exposure, and colder for under-exposure. So soon as sufficiently developed, immerse for five minutes in a bath of

Alum	1 part.
Water	40 parts.

Wash well, and after drying, mount in the usual way. Ordinary printing negatives are more suitable for carbon printing than the thin ones often used in transparency printing.

Should the prints not be sufficiently dark or vigorous, they may be intensified like an ordinary wet collodion negative, or immersed in a bath of protosulphate of iron and gallic acid.

Although a fair outline of the process is here given, for further particulars the reader is referred to the "Autotype Company's Manual," popular edition, or to the excellent new publication,

"A Manual of the Carbon Process," by Dr. Paul Liesegang, translated from the German by Mr. R. B. Marston.

MOUNTING OF LANTERN SLIDES.

LANTERN SLIDES should always be protected by a plain glass in front, with a paper mount between the glass and the picture of a suitable shape,—either round, cushion-shaped, or dome. A good plan is to have these mounts black on one side and white on the other, the white side being convenient for writing the name of the picture, and should be next the plain glass, so that when exhibiting it may be easily seen; thus by adopting one regular system of placing the white side next the condenser the

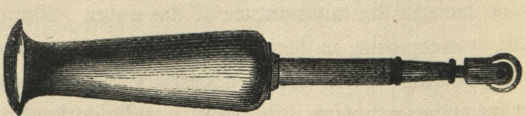


Fig. 61.

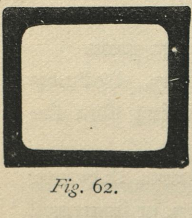


Fig. 62.

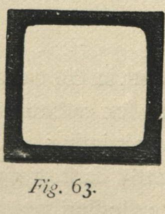


Fig. 63.

Fig. 64.

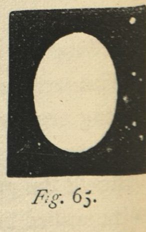


Fig. 65.

pictures will always appear the natural way on the screen. This latter is important, more especially in the case of a slide which exhibits a clock or a printed sign. The mounts for the purpose of mounting are most easily cut by using the "Photographic

Trimmer" (Fig. 61), and the shapes for same (Figs. 62, 63, 64, 65), which latter may be procured in a variety of forms and sizes. With this little instrument the smallest curves and circles may be cut as clean and sharp as possible to imagine, the only instructions necessary being to keep the cutter pressed well up to the inside edge of the mount, and with one sweep to go round the whole. A sheet of zinc forms an excellent medium for cutting upon. The edges of the slide should be bound with paper, the best for the purpose being the sort in which needles are wrapped, and known commercially as "needle" paper. Gelatine or gum tragacanth are good adhesive mediums.

The old-fashioned method of mounting slides in wood frames should be abolished, as not only is the expense greater, but they take up much more room for storage, and are less portable; moreover, unless stopping-pieces are attached, arranged to the width of the slide stage of lanterns (which unfortunately are not always alike), the pictures will be far from registering on the screen; whereas, by dispensing with the wood frames, no greater liability to breakage is incurred, and they may be used by means of a suitable carrier in any lantern, by this means giving absolute registration. As some of our readers may not understand the benefit of correct registration, a few words on the subject may not be out of place. What is meant by correct registration is that when dissolving one picture away, the following one should take its place identically, and without any alteration in the margin of the picture being observed. Let us take the picture of a landscape in summer, in which a cottage, trees, etc., may be present, dissolving into one of the same subject identically, but in winter-time. The two should be so dissolved that one takes up the place of the other exactly, the transformation being effected without the observers becoming aware of the change taking place until the effect

is actually attained. Should the registration be neglected, the second picture most probably will make its appearance out of place, and there will be seen a double picture, until such time as the operator has moved the slide into its proper place. This shifting of slides when once on the screen mars the whole effect, and in many instances has the writer known this want of registration to spoil what would have been an enjoyable entertainment.

CARRIERS.

IT is a pity that all lantern slide producers could not have agreed upon one definite size as a standard. As it is, some make them $3\frac{1}{4}$ square, others $4\frac{1}{4} \times 3\frac{1}{4}$, and the French size being $3\frac{7}{8} \times 3\frac{1}{4}$, while many amateurs make the slides out of stereoscopic plates cut in halves, namely, $3\frac{3}{8} \times 3\frac{1}{4}$. All seem to have adopted the $3\frac{1}{4}$ in depth, therefore the most practical forms of Carriers are those in which the pictures are slided through. Thus, one having been placed in the carrier, a second one is introduced, which pushes the previous one into its place; a third one now pushes the second into position, and simultaneously projects the first one to the outer end of the carrier, so that it may be removed. The slideholder shown at Fig. 66 is intended for pictures to be passed through it in a panoramic fashion, but as the slides are carried on a piece of tape placed round two small pulleys, the movement is apt to be very

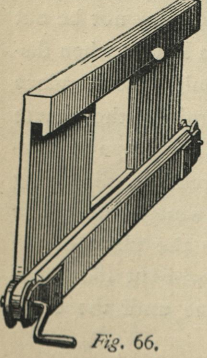


Fig. 66.

unsteady; moreover, the mounts forming the margins of the pictures in passing through present to the eye an unseemly black patch, increased the more by the ends of two pictures being together.

REGISTERING CARRIER.

A Registering Carrier was some time ago introduced by the author, in which slides of all the usual sizes could be used indiscriminately with perfect registration. A description of the same was published in the "British Journal Photographic Almanac" of 1878, and is here reproduced (Fig. 67).

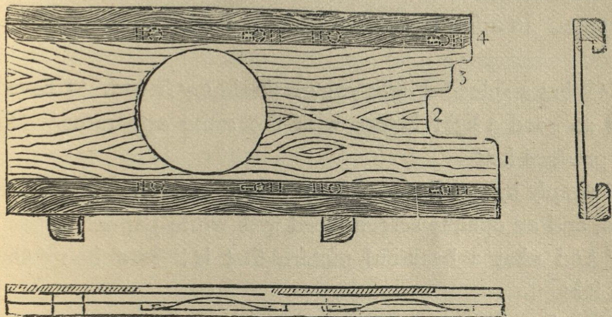


Fig. 67.

"Some time ago I went to an exhibition of dissolving views given by a friend. He had a most elaborate apparatus and some good views, but they were badly exhibited. The first picture shown, after being set in position, looked very well; the second made its appearance some two or three feet out of its intended position, and had to be moved during the dissolving; the third came on similar to the second, considerably out of place; and during the whole of the exhibition the pictures had to be adjusted during dissolving. Sometimes there would be a round picture, then a

cushion-shaped one, and afterwards a dome, causing an everlasting shifting about, which, added to the noise of the carriers being removed and replaced in the lanterns, very much detracted from the enjoyment of the evening. I was quite disappointed at the management of my lantern friend. At the close of the exhibition I remarked, 'You ought to register your pictures better on the screen.' He seemed to make light of the matter, therefore I invited him to spend an evening with me, and I would show him how I obtained a far better result with much less noise and trouble. On the appointed evening my friend arrived, and after a little refreshment we retired to the room where I usually exhibit my lanterns. In a few minutes I had my Sciopticons at work, using oil.

"'What a splendid light you get!' said my friend. 'I have never seen so good a light before with the same apparatus. How do you produce it?'

"'Simply by good oil, wicks properly cut and trimmed, lenses clean, and an opaque screen faced with white paper.'

"'And what a beautiful picture that is!' said he: 'America, isn't it?'

"'Yes.'

"'Whose slide is it?

"'Woodbury's.'

"'It's very nice, but I don't like the size' ($3\frac{1}{4} \times 4\frac{1}{4}$). 'I have bother enough with slides of different sizes already, and I don't care to introduce another.'

"'Well,' I replied, 'I think the Woodbury slide the best size, and can give you many reasons for it. One is that you have only one chance of getting the picture the wrong way, whereas in the square slide the chances are three to one. However, let us go on.'

"My second picture came on very nicely.

"'That's good too,' said my friend. 'Is that a Woodbury slide?'

"'No, it's York's' ($3\frac{1}{4} \times 3\frac{1}{4}$). So I varied by putting in a square slide, then a Woodbury, changing them about indiscriminately for some eight or nine pictures, when my friend turned round, remarking,

"'How beautifully they dissolve, and how accurately they register! There is not the slightest alteration in the margin, notwithstanding you use slides of different sizes every time' (which I did purposely). 'How do you manage it?'

"'By means of my carriers, which are fixtures in the lanterns, the aperture in them forming the margin of the picture, being slightly less than the paper mount inside the slide; and both carriers being exactly alike, the pictures are simply passed through. Also on the carriers I have different lengths, or stopping-edges, suitable for the different sizes of slides.' (This the accompanying drawing will show).

"My friend was so highly pleased with the carriers that he ordered a pair the next day. I have shown them to many lantern friends, who all acknowledge their simplicity and efficiency. I shall be glad to see any improvements that your readers may suggest. It will be seen from the drawing how the carrier is applied. In placing a picture into the carrier to start with, it needs no fixed stop; the second picture, according to its size and that of the first one, must be pushed to one or other of the stopping-edges, by which means the first picture will be pushed into its right position in the centre of the disc. Thus, suppose the first picture to be $3\frac{1}{4} \times 3\frac{1}{4}$, and the second to be $3\frac{1}{4} \times 3\frac{1}{4}$, use Stop No. 2. Now, suppose the first picture to be $3\frac{1}{4} \times 4\frac{1}{4}$ (Woodbury size), and the second picture the same size, use No. 1, or, as I always remember it, the longest slide and the longest stop, also the shortest slide

and the shortest stop; and suppose you use a Ferrier size, stop No. 4; in case you have $3\frac{1}{4} \times 3\frac{1}{4}$ in the carrier, and the next picture is $3\frac{1}{4} \times 4\frac{1}{4}$, use also Stop No. 4; in case you have a Woodbury slide in the carrier, and have $3\frac{1}{4} \times 3\frac{1}{4}$ following, use Stop No. 3. Although this may seem a little complicated at first to some as I have explained it, I can assure you in practice it is very simple. It will be seen from the diagram that the grooves are very wide, suitable for the thickest slide, and by having two little springs arranged in the grooves at the top and bottom, the pictures are always kept in one definite position, preventing the passage of one slide over the other, or the possibility of two slides getting locked, as is often the case with thin French slides. Another advantage is that after once focussing, readjustment is seldom, if ever, required."

In using this carrier with a single lantern, the objection of the dark margin at the end of each slide, mentioned in connection with the panoramic carrier, is not so great when changing the picture: its definite position being known, it may be pushed into its position with one sharp movement; thus, for comic slides (which should never be dissolved) it will be found to answer admirably.

STATUARY.

SCARCELY any subject of photography can be shown on the screen to excel that of Statuary. In many cases these are stopped out with Indian-ink, and nothing is seen but the simple statue upon a black ground in bold relief. One very effective way to exhibit this class of slide by a dissolving lantern is to dissolve them into blue glass. This is done as follows: First place a blue glass in one lantern (sheets of coloured gelatine will answer the

same purpose, and may be made to any required depth of shade), and through it project a disc on to the screen. A statuary slide is now placed in the other lantern, and the dissolving conducted very slowly until the statue appears in full, with the shadow portions a deep blue in comparison with the lighter parts; now gently dissolve back again, leaving the blue disc; change the picture, and proceed as before.

A more effective way of exhibiting statuary slides is by means of two slide tinters (shown at Fig. 68). These consist of flanges

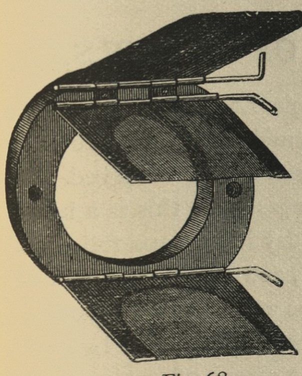


Fig. 68.

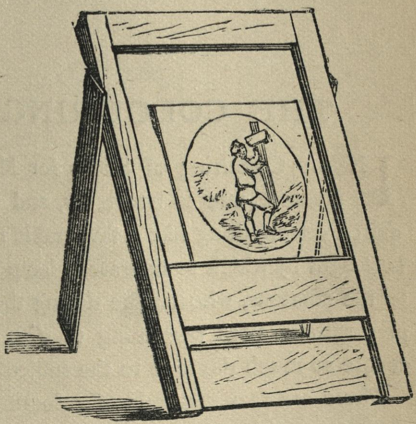


Fig. 69.

fitted to the front parts of the objectives, on which are fixed metallic frames, each holding a sheet of thin coloured gelatine; an opaque shutter is also attached to each, for application when it is necessary for the lanterns to remain in darkness. The method of procedure is thus: Project a picture on the screen through the gelatine; now gently raise the frame holding the gelatine until the picture has increased much in brightness; then gradually lower

the frame. With the second lantern a similar operation will be performed; so that, while dissolving one picture into the other, both frames will be down.

The slide tinter is very useful for a variety of effects, such as sunsets, moonlights, etc.; also for giving to ordinary photographs, in many cases, the effect of a coloured slide, by the judicious application of different coloured sheets of gelatine for sky and foreground. These different sheets may be introduced into the frame at will.

THE COLOURING OF SLIDES.

IN the Colouring of Slides for Magic Lantern purposes the greatest care is necessary, and considerable practice is required ere anything like a favourable result can be achieved. The best light by which to operate is lamp or gaslight: this is a benefit to the amateur, whose time during the day is perhaps fully occupied with matters pertaining to *£ s. d.*, and therefore could not devote so much daytime to the subject as would insure success.

There are two methods of colouring upon glass, one by means of oil or varnish colours, and the other by means of water colours. The latter is the most recently introduced, and its rapid growth is not a little remarkable, and the amateur is surprised to find how simple and easy it is in comparison with the old method of oil colouring. It takes much less time, the picture is less liable to injury during the process, and it requires no heat to dry. Photographs may be coloured, but in their manipulation the greatest care and discretion must be exercised, or the result will be worse than a coloured engraving.

At Fig. 69 is shown the kind of easel used for the purpose, the slide to be coloured resting upon the glass back.

Fig. 70.

All the necessary materials (and those of the very best quality) are to be obtained from Mr. J. T. Middleton, of High Holborn, who has made a specialty of their production, and also publishes a a very comprehensive and complete Guide Book on the subject. From the above gentleman can also be obtained outlines on glass (Fig. 70) for colouring, as well as all the different kinds of frames and mechanical contrivances suitable for comic slides.

EFFECT SLIDES.

IN using Effect Slides, two or more lanterns are necessary. These slides are usually hand painted, although, of late, photography has been turned to good acconnt in this direction, and, notwithstanding the extra care and trouble in their preparation, they amply repay for this expenditure.

Some very wonderful effects can be produced; among these are the change from day to night, summer to winter, the formation of rainbows, tempests at sea, with shipwrecks and lightning, the storming of forts, etc.

To more clearly illustrate the object of effect slides, let us de-

Fig. 71.

Fig. 72.

scribe an exhibition of a set of slides called the "Orphan's Dream." This set consists of two slides (Figs. 71 and 72). In one lantern is placed the foundation slide (Fig. 71), representing a child asleep upon a couch, and in the other lantern is placed the *effect* slide (Fig. 72). First the foundation slide is displayed; and then, on

commencing the dissolving, the effect will be made to appear gradually and then disappear.

A set of effect slides, the production of Mr. F. York, and illustrating the tale of "Gabriel Grub" from Dickens's "Pickwick," are a very excellently effective and amusing set. Those who have read the tale will remember how the old sexton, Gabriel Grub, was spirited away, and made to see a variety of curious sights with the King ot the Goblins. These are very beautifully portrayed.

In cases where several effects follow alternately, two lanterns may be used, by placing the foundation picture in one, and dissolving the *effects* alternately in the other lantern; but by far the best plan is to use three lanterns, and by this means the dissolving is made perfect. Thus, in the slides of the "Soldier's Dream," the principle or foundation slide represents a soldier fallen asleep on the battle-field, beside the camp fire. He is supposed to be dreaming, and the vision of a happy home is caused to appear in the smoke of the camp fire by means of a second lantern; now this vision is changed to one of departure for war, and followed by engagements on the battle-field, and victory in the end. It will be seen that the foundation slide must remain on the screen the whole time, and will therefore occupy one lantern. The first effect slide must be placed in the second lantern, and made to appear; the second effect slide must be placed in the third lantern; and by these two latter lanterns the effects may be dissolved without interfering with the foundation slide. In some effects even more than three lanterns are required, and at the Royal Polytechnic Institution as many as six lanterns have been in use at one time for the production of effects, such as the Siege of Delhi, in which the fire of artillery, the bursting of shells, etc., are portrayed. Four lanterns are most frequently used at the above institution. An illustration (Fig. 73) on next page shows before and

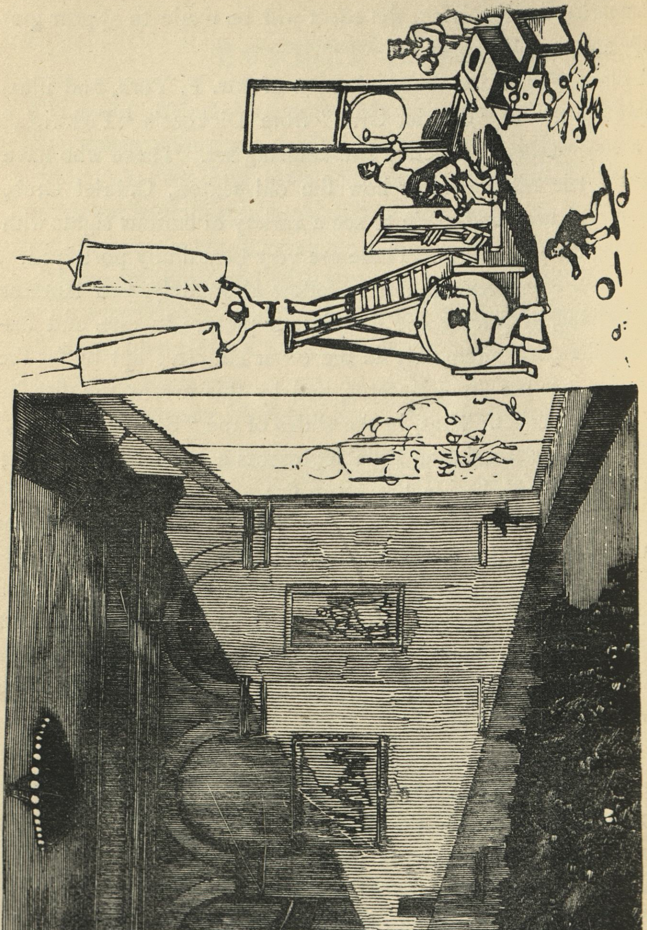


Fig. 73.

behind the scenes at the same institution during a lantern exhibition of the above description, and is taken from Professor Pepper's "Play-book of Science," by permission of the publishers.*

"The optical effects were assisted by various sounds in imitation of war's alarms, for the production of which more *volunteers* than were absolutely required would occasionally trespass behind the scenes, and produce those terrific sounds that some persons of a nervous temperament said were really *stunning*."

MECHANICAL SLIDES.

The above embrace a variety of scientific as well as comic slides, and no class of picture can be made more entertaining or instructive than a really good set of Astronomical Slides. Among this class comes the

CURTAIN SLIDE,

which is usually a curtain, hand painted, of red colour, and arranged so as to imitate a theatrical drop scene, with all the necessary tassels, cords, valences, &c.; occasionally an appropriate inscription or a device forms a centrepiece. This slide is mounted in a wood frame, to the back of which is fixed a roller, upon which is wound a piece of opaque calico. When the slide is in the lantern, in an inverted position, the roller should be at the top, so that when the calico is drawn down no light can pass through; but upon giving motion to the roller the calico is wound up, and gives the appearance on the screen of the curtain rolling down from the top. Should it be desired to wind up the curtain, the calico must be lowered.

This slide is very effective as an introductory slide to a series of views, especially if a lecture or description is being given. The

* See also Professor Pepper's more advanced work, "Cyclopædic Science Simplified."

curtain is exhibited, and the lecturer announces his subject, and gives any introductory remarks. By a little careful management the curtain can be wound up and the dissolving commenced slowly, so that the first picture may make its appearance as if it were actually behind the curtain. A beautiful mechanical effect is produced by the mechanical rackwork slide, the CHROMATROPE (Fig. 74). This was invented by Mr. Childe, the inventor of dissolving views. It consists of two discs of glass painted in brilliant transparent colours, generally radiating from the centre to the outside, and forming, when placed face to face, the reverse of each other. The handle on being turned gives a rotary motion to the glass discs in opposite directions. The result is an ever-varied change of design and colour.

A great variety of designs can be adapted to the same mechanical arrangement for displaying geometrical and chromatic effects. Two pieces of perforated zinc introduced give some very extraordinary geometrical effects, also two pieces of wire gauze give a variety of designs of the watered silk type.

The Windmill (Fig. 75) is another rackwork slide. In this case only one disc is caused to revolve, that one on which the sails of the mill only are painted, the landscape being painted on a fixed disc. Similar to this is a slide of a mill with the water-wheel in motion, also a slide representing a man swallowing rats.

TRANSFORMATION COMIC SLIDES are made in an endless variety of subjects. The one illustrated at Figs. 76 and 77 represents a wicked monkey, who, having caught a cat, persists in dipping pussy over head in the water-tub.

LEVER SLIDES (Figs. 78 and 79) are made of two discs, one of which only is made movable. Thus, for instance, one representing a cow having come down to the water to drink, has the body only of the cow painted on one disc, while the head and neck are painted

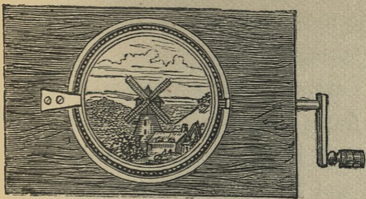


Fig. 75.

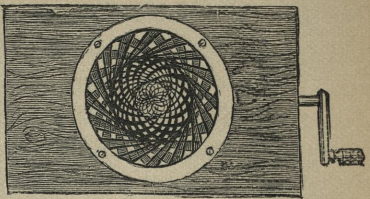


Fig. 74.

Fig. 76.

Fig. 77.

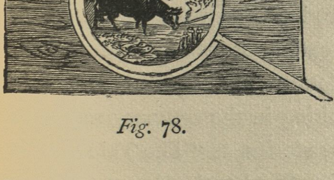


Fig. 78.

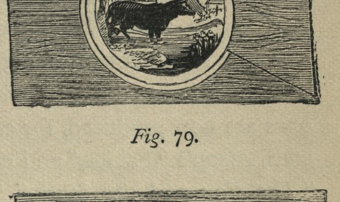


Fig. 79.

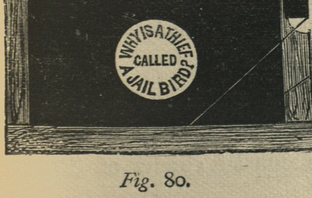


Fig. 80.

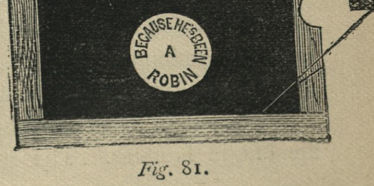


Fig. 81.

on the movable disc. On the movement of the lever the cow is represented very naturally as taking a drink.

CONUNDRUM COMIC SLIDES are similar in construction to transformation comic slides. The frame simply carries an opaque plate, in the centre of which an aperture is cut, and on the loose sliding glass is printed a conundrum, and adjoining it the answer. The conundrum being just shown, the answer is seen by pulling out the slide. Figs. 80 and 81 represent the positions during question and answer.

One of the best mechanical comic slides ever invented is Beale's Choreutoscope. It consists of a frame containing one long slide, on which is painted a skeleton in six different positions. In the frame is an aperture, so that one only of the positions can be seen at a time. A handle is so arranged at the back that by turning the same, each position of the skeleton is made to appear alternately, and by a very ingenious cam motion the transit from one position to another is performed instantaneously; also a shutter is caused to close the aperture entirely at the time of transit, thereby preventing the possibility of any one seeing any portion of two positions at once. The effect produced on working the handle is that of a skeleton performing an extempore step dance.

In addition to the *mechanical* comic slides, a variety of humorous ones are now produced, for exhibiting in the ordinary way nursery tales, Æsop's "Fables," and comic stories, as "The Tale of a Tub," "The Fox and the Stork," "The Elephant's Revenge," etc., all conducive to the greatest merriment. Motto Slides, such as "Welcome," "Adieu," "Good night," etc., if judiciously used, give *éclat* to an entertainment.

CHROMO PICTURES.—Messrs. J. Barnard & Son, of 339, Oxford Street, London, have published a variety of the above for use in the Magic Lantern. The subjects consist chiefly of Scriptural

stories, "Æsop's Fables," natural phenomena, dissolving view effects, and a long list of comic slides. These pictures are printed upon paper in highly brilliant and transparent colours. By using the materials supplied, and keeping to the instructions given, the amateur may soon increase his stock of slides, at a small cost and little trouble. A full description of the whole series of views is contained in a little book, entitled "Evening Entertainments for the Magic Lantern," published by Messrs. Barnard & Son.

Having now considered the different forms of lanterns, with their details and appliances, as well as the various classes of pictures, it may be as well to say a few words as to the most effective way of viewing a lantern exhibition. It must be admitted that, however fine a picture or a photograph may be when viewed in the hand, upon being magnified on the screen some two or three thousand times, its defects will be manifest by a near observer, and it is well known that many very beautiful pictures viewed from a distance assume a flat, coarse, and dauby appearance upon closer inspection. Now, by uniting these facts, we arrive at the proper position for viewing: the nearer we are to the screen, the coarser and flatter will the picture be seen, and as we recede, its defects become less apparent; but were we to recede too far, not only would the defects disappear, but also the details, so that under these circumstances the best position for viewing is close to the lantern.

Some attempts have been made to show pictures on the screen in relief, similar to stereoscopic representations, and some experimentalists have actually asserted their success in combining binocular pictures by means of two lanterns. A very little study of binocular vision, or of the stereoscope, will convince any one that such an effect is impossible to produce.

From the introduction in Sir David Brewster's work on the stereoscope, published by Mr. John Murray, the following is extracted :—"When the artist represents living objects, or groups of them, and delineates buildings or landscapes, or when he copies from statues or models, he produces apparent solidity, and difference of distance from the eye, by light and shade, by the diminished size of known objects as regulated by the principles of geometrical perspective, and by the variation in distinctness and colour which constitute what have been called aërial perspective; but when all the appliances have been used in the most skilful manner, and art has exhausted its powers, we seldom, if ever, mistake the plain picture for the solid which it represents. The two eyes scan its surface, and by their distance-giving power indicate to the observer that every point of the picture is nearly at the same distance from his eye. But if the observer closes one eye, and thus deprives himself of the power of determining differences of distance by the convergency of the optical axes, the relief of the picture is increased. When the pictures are truthful photographs, in which the variations of light and shade are perfectly represented, a very considerable degree of relief and solidity is thus obtained, and when we have practised for a while this species of monocular vision, the drawing, whether it be a statue, a living figure, or a building, will appear to rise in its different parts from the canvas."

And at page 46 of the same work :—"When we view a picture with both eyes, we discover, from the convergency of the optic axes, that the picture is on a plain surface, every part of which is nearly equidistant from us. But when we shut one eye, we do not make this discovery, and therefore the effect with which the artist gives relief to the painting exercises its whole effect in deceiving us, and hence in monocular vision the 'relievo' of the painting is much more complete."

As this applies equally to the picture on the screen, it is clearly shown that with one eye the best effect is obtained, and the nearer the observer is to the screen, the more important this becomes.

DESCRIPTIVE LECTURES.

WHEN slides can be shown in series, lectures or descriptions of the views should be given, not necessarily a formal lecture, as from the amateur they are more effective when spoken than read. Set lectures are to be purchased, at small cost, on very many subjects, or can be arranged from tourists' guide books, which can be got of the whole world. After all the slides are arranged and numbered in boxes in the order to be shown, each slide should be taken out separately, and the lecturer should now rehearse several times in private his description, with the slides before him, and if needs be, pointing out the places of interest, as he will when the picture is on the screen. Even when slides are not in complete series, and the exhibitor has to make up his entertainment by slides of various places, one or two of London, a few of Paris, Switzerland, Egypt, etc., a description of the views should in all cases be given, for instead of simply calling out "the Pyramids of Egypt," if something can be said of their age, by whom built, and for what their supposed purpose, their size, position, etc., a double interest is given to the picture. It is as well in giving a mixed entertainment, or "Scenes in Many Lands," to keep those belonging to one country together, also those of another, and let the whole be exhibited in something like order, as nothing looks more disorderly than first to be shown a picture in America, then one of Paris, next one of Niagara Falls, etc. A little music will add much to the

charm of an exhibition, care being taken that the airs selected should be in keeping with the subjects shown. National airs may be introduced in their proper places with effect, but nothing would appear so ridiculous as to hear the tune of "Johnny comes marching home again," to a picture of "the Return of the Prodigal Son" on the screen.

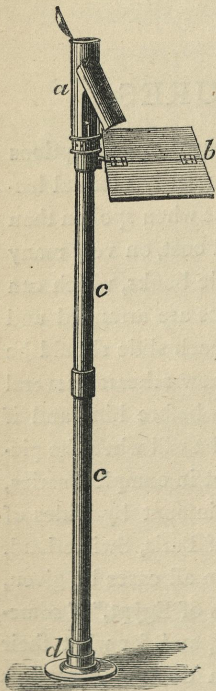


Fig. 82.

READING DESK.

A MOST useful and portable combined Lamp and Reading-Desk is shown in Fig. 82, fitted up for use.

The Lamp is similar to the ordinary railway travellers' carriage reading-lamp, in which standard size candles are used, and which are fitted into a spring socket, so that the flame is always kept at the same level. This lamp A is fixed on the top of a rod C C, which for the convenience of packing is made in two lengths, coupled in the centre by a ferrule. The lower end of the rod is fixed in a brass socket D, which forms a foot; underneath this is a short strong taper screw, by which the whole is fixed to the floor.

The desk is composed of two thin pieces of wood hinged together, as shown, and is attached to the stand by means of a hook and socket just below the lamp, which is also provided with a silvered reflector and an adjusting flap, answering the double

purpose of throwing the light on to the desk whilst preventing the light from escaping into the room.

The whole is of perfect workmanship, combining general efficiency with the greatest portability and lightness.

SCIENTIFIC PROJECTIONS.

IT seems very surprising that the attention of science teachers has not been more given to the Magic Lantern, although latterly many are becoming alive to the importance of its application, for not only can an effect be more clearly shown to a large assembly, but less bulky and less expensive apparatus are needed. Moreover, only one subject being treated at a time, the attention of the student can be more closely concentrated on the one point. It is to be hoped that more consideration may be given to this instrument as a medium for scientific education, and as appliances and apparatus are becoming more general, we may look forward to the time when almost every branch of science may be illustrated by projection, with equal facility and better effect than can be produced at the lecturer's table.

DIAGRAMS,

or Drawings for the illustration of Lectures, may be made as follows :—

A piece of glass of usual size for lantern slides is rubbed with tallow, or waxed, then held over the flame of a piece of burning camphor : this will give it a perfectly opaque surface, upon which Diagrams may be drawn, or it may be written upon with a fine point. These, when projected upon the screen in the usual way,

have the appearance of chalk drawings upon a black ground. These may be protected by another glass, and made up as an ordinary slide. For copying drawings or diagrams Mr. Woodbury says: "An excellent medium is formed by making a varnish of gum dammer in benzol of the ordinary consistency, and adding a few drops of india-rubber to the same solution. This dries perfectly transparent, and allows of the finest writing to be made upon it by means of a steel pen and Indian-ink. When circles are required, the centres may be obtained for the compasses by damping a piece of card and attaching it, removing same when done with. By coating mica with this, all sorts of designs may be quickly traced from any scientific work."

For a Demonstrative Lantern few are more suitable than the "Sciopticon," which may be used with its powerful oil-burning lamp for small results, or also with the lime light if necessary.

The slide stage, a portion of which is removable, is most conveniently arranged for the adaptation of most kinds of philosophical appliances; the objectives are easily removed; and the condensers are arranged from the *outside*, thus offering greater facilities than the old style of lantern with the condensers inside.

OPTICAL EXPERIMENTS

may be exhibited: parallel, converging, and diverging rays may be shown by the condensers, and intensity of illumination, refraction, and a variety of optical phenomena are all within its reach.

THE MICROSCOPE

is a valuable attachment to the Magic Lantern. The lenses introduced are of much shorter focus than the ordinary lantern objectives, and the object must be a greater distance from the condenser.

The best position is shown at Fig. 83, C being the condenser, S the slide, and O the objective. The rays emanating from the condenser will cross at the focus, and then diverge, the objective

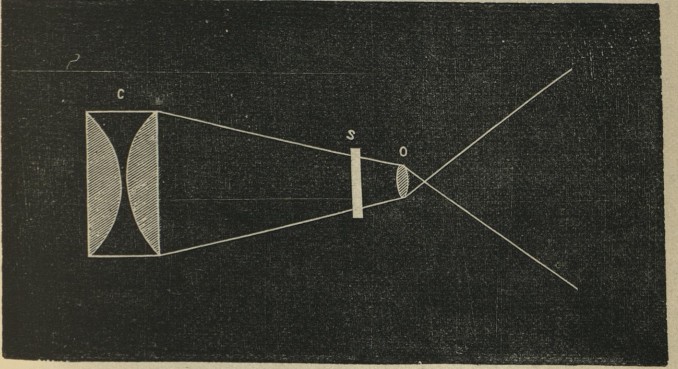


Fig. 83.

being so placed that all, or as much light as possible, may pass through it. The light may be drawn back so as to obtain the best result. It is most important in using this adaptation that all the parts be central.

When objects are to be shown a large size, enlarged micro-photographs are used; but these are never so good as originals, being devoid of their natural colours. As most microscopic slides are mounted with Canada balsam, they must not be kept too long in the lantern, or they may be seriously injured by the heat concentrated upon them. The extent of magnifying power which may be employed is limited by the amount of light obtained in illuminating the object, so very high powers or large discs should not be attempted with anything less than the lime or electric light.

During the Franco-Prussian War, when Paris was in a state of

siege, and communication with the outer world deemed an impossibility, despatches and copies of newspapers were, by means of photo-microphy upon thin films of collodion, carried by pigeons to the interior of the capital. These films, which were about 2 inches long by 1 inch wide, contained each copies of sixteen pages of despatches, each page consisting of 5,000 letters, the reduction being the eight-hundredth part of the size of the original. Twenty of these despatches could be carried in a quill attached to the tails of these novel postmen. As soon as the despatches were received at the telegraph office, they were placed between two plates of glass and placed in the microscope lantern, the electric light being employed, and the characters were reproduced of sufficient size to be read and copied with ease. An illustration of this forms our Frontispiece.

Objects suitable to the lantern microscope are whole insects, butterflies, wood sections, and fine crystals of many chemicals, such as sulphate of copper, sulphate of iron, chloride of ammonium, chloride of barium, alum, camphor dissolved in water, etc. A variety of tank experiments also may be introduced, as the animalculæ in water, suitable water for examination being found in stagnant pools, or water in which flowers or hay have been standing for some few days. A very pretty effect may be witnessed of the formation of crystals if a piece of glass be wetted with a strong solution of Epsom salts, and then placed in the microscope. In a short time the water will evaporate from the upper edge, and crystallization will at once begin; if too slowly, it may be hastened by blowing upon the surface of the rod; very soon the screen will be covered with a representation of a beautiful crystalline formation. A most convenient screen for exhibiting microscopic objects may be made by tracing-paper, stretched on a youth's wooden hoop, as described at page 82.

THE OXY-HYDROGEN POLARISCOPE.

This is an instrument with which one of the most interesting branches of science can be studied. To attempt an explanation of the remarkable phenomena of polarized light is entirely out of the limits of this treatise, therefore we will content ourselves with a description and method of applying the instrument. The peculiar properties called polarization may be imparted to light in various methods of refraction and reflection.

It is about forty years ago that Mr. J. F. Goddard received the silver medal of the Society of Arts, for his invention of the "Oxy-hydrogen Polariscope," illustrated at Fig. 84. Thus described:

"In this instrument, A represents the oxy-hydrogen blow-pipe, B the lime-cylinder, and diverging rays of light refracted by the condensing lens C C C, and falling upon a mirror B B, consisting of plates of flattened crown glass placed in the elbow of a tube, bent to the polorizing angle of crown glass; D, converging rays of polarized light reflected from the mirror; H H, a bundle of sixteen plates of mica for analysing the light previously polarized by reflection; E, a double-reflecting crystal (film of selenite,) placed in focus of the object glass (I), which forms an image of the crystal upon a disc or screen at R. As the analysing bundle of mica is caused to revolve, the image of the selenite upon the disc undergoes all the change, and exhibits alternately the primary and complementary colours at the same time, one being reflected in the direction S, and the other transmitted and seen at R. "The great advantage of polarizing the light from a number of plates is, that a beam of any required dimension can be obtained, also of much greater intensity than by any other means; for whatever single surface may be employed, that polarized light at the same angle as the glass used (which for crown glass is 56 45,) we obtain an additional quantity by laying upon it a single plate of such glass, and a further

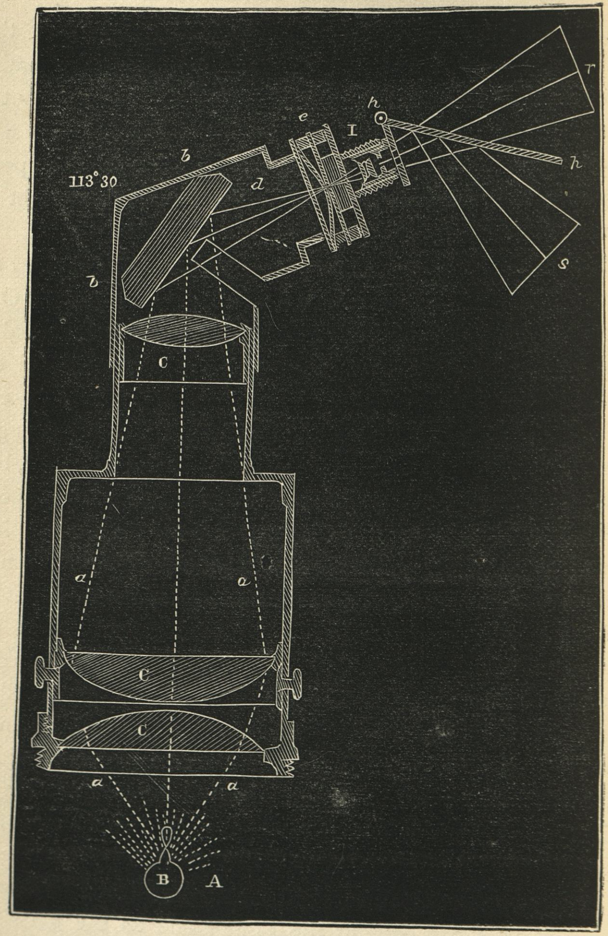


Fig. 84.

quantity by the addition of a second, third, or any further num

ber. The quantity of light added by each succeeding plate being, however, less in proportion to the number of plates through which it has to pass. In this respect the single-image Nichol's prism of Iceland Spar is decidedly the best for analysing, as by this a great variety of objects may be exhibited." The latter Nichol's prism analyser is, therefore, most generally used, being mounted in a tube by which it may be revolved in front of the objectives, the subjects for examination being placed in the rays of polarized light, between the mirror or polarizer and the objective. From the optical instrument makers may be obtained transparent butterflies, flowers, and other objects made from thin films of crystals, of selenite, or mica, and when these are placed in the polariscope, the most brilliant variations of colour are projected on the screen as the analyser is made to revolve.

THE SPECTRUM,

or Dispersion of Light, and also Spectrum Analysis, may be fairly conducted by the oxy-hydrogen lantern, but for the latter purpose

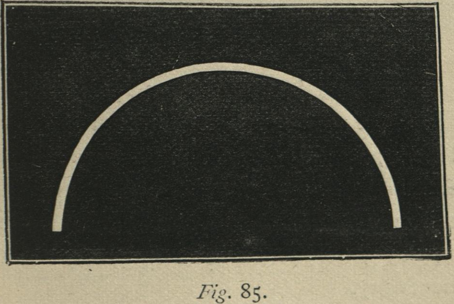


Fig. 85.

a special kind of jet is required. To show the Spectrum by means of the lantern, perhaps no way is more effective than that of the

rainbow as an effect upon a landscape picture, or upon such a view as Niagara Falls. To accomplish this a second lantern is indispensable, one for the view, the other for the rainbow. The view is shown on the screen by the one lantern in the usual manner. A piece of sheet brass or tin, in which is cut a semicircular slit, as shown at Fig. 85, is next placed in the second lantern, thereby projecting a semicircle of white light. A prism must now be placed in front of the objective, which will cause the semicircle of white light to leave the screen, and probably on the floor or the ceiling it would be seen, but not as before, for by the introduction of the

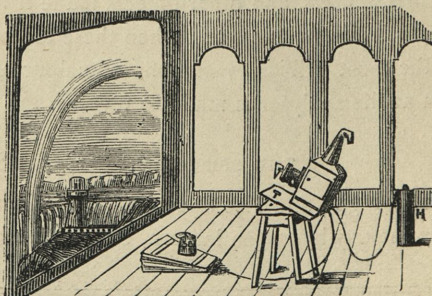


Fig. 86.

prism the light would be decomposed, and present a fair illustration of the colours of the rainbow. The lantern must now be raised in front so as to bring the effect on the screen into its proper position, as at Fig. 86. It is often more convenient to turn the lantern sideways than to elevate it in front, and by using the prism in a vertical position an equally good effect can be obtained, but a larger prism is rendered necessary.

THE KALEIDOSCOPE.

This instrument, the invention of Sir David Brewster, has been

for years before the public, and is almost an universal favourite. Its adaptation to the lantern has been accomplished, notwithstanding very many difficulties. Mr. Darker, of Lambeth, has devoted much time and attention to this adaptation, and the one exhibited at the Royal Polytechnic is of his manufacture. It may be briefly de-

Fig. 87.

scribed thus: A pair of plain mirrors, fixed inside a brass tube, at each extremity of which is placed a lens, the one placed nearest the lantern condenser being a meniscus, and at the other end being plano convex. In other words, it forms a lantern objective, with two plain mirrors inserted in the position of a V between the lenses. The light must be raised above the centre of the condensers, and upon the proper adjustment of the light and the exact centring of the optical arrangements its success much depends. This instrument cannot be used in connection with the lantern with any

satisfactory result, except by lime-light, and even then to no large size. One great difficulty is experienced by the collection of moisture upon the plain mirrors, which greatly detracts from a perfect illumination. In the Kaleidoscope sometimes a third reflecting mirror is employed, a cross section of the three forming an equilateral triangle. A pattern or design produced by such an arrangement is shown at Fig. 87. Various substances may be introduced to produce different effects, such as broken coloured glass, pins, needles, etc., which can be inserted by removing the meniscus lens from the tube.

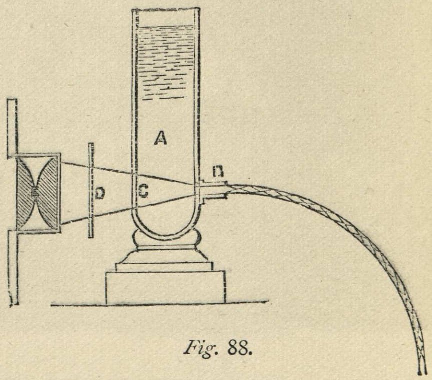


Fig. 88.

TOTAL REFLECTION.

The "Illuminated Cascade" will well repay the trouble of its production. This effect was shown some years ago at the Royal Polytechnic Institution, where Mons. Duboscq, of Paris, erected a very elaborate arrangement, the exhibition causing universal admiration. To exhibit this effect on a small scale, the apparatus necessary consists of a tall glass vessel, supported on a stand, and placed in front of the condenser, the objectives being removed. An illustration is given at Fig. 88. The vessel A must be wholly covered

with black paper, except at C, where the rays of light from the condenser enter, and are brought to a focus at B, which is a circular orifice, from which a stream of water issues in the form shown; the rays of light, being carried with it, are reflected from side to side of the arched column of water, which is illuminated in a most lovely manner through its course. If various coloured glasses be inserted at D, the effect produced is still more beautiful. To insure success, the orifice B should be perfectly round and smooth, allowing the stream to issue unbroken; and when adding more water, it must be done very quietly, so as not to cause a current, or the effect will be lost.

An experiment illustrating the

REFRACTION OF GLASS

may be shown as follows:—After preparing a glass plate with burning camphor, as previously described, draw upon it a line or an arrow about 2 inches in length. This, upon being inserted in the lantern, will show a white line or arrow upon the dark ground. Now take a strip of glass about $\frac{1}{2}$ inch broad and $\frac{1}{4}$ thick, insert it in front of the slide at right angles to the arrow or line: so long as it is kept at right angles, no refraction will be seen; but on inclining it so that the rays of light shall pass through it obliquely, a piece of the arrow or line will appear to be cut out and moved to one side: the thicker the glass the greater the displacement.

THE PERSISTENCE OF VISION

may be illustrated by a little instrument styled a Kaleidotrope. It consists of a disc of tin perforated, as shown in Fig. 89, attached to the wood block by means of a lateral spiral spring, being free to revolve upon its centre point. When projected on the screen nothing more is seen than a number of white spots, but upon giving

motion to the disc by a touch of the finger, circles of light are seen beautifully interlacing one another. The principle is that of "Persistence of Vision," and may be compared to the boyish experiment

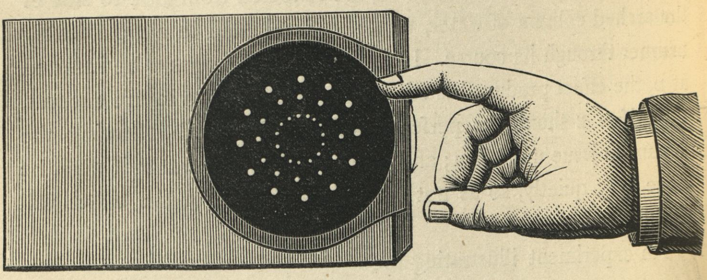


Fig. 89.

of whirling round a lighted stick, and so causing an apparent circle of light.

COLOUR EXPERIMENTS

form a most interesting branch of science, and are easily conducted by means of the Magic Lantern. A series of such experiments were published some time ago by Mr. W. B. Woodbury, from which the following are extracted. Two discs of thin cardboard are obtained, in each of which must be cut three circular apertures. Three pieces of different coloured gelatine are now attached to the backs of each disc, a yellow piece covering one aperture, a red the second aperture, and a blue piece the third; so that upon looking through the disc it will present three circles, one red, one blue, and one yellow. Should these discs be placed in a chromatrope-holder, and made to revolve in opposite

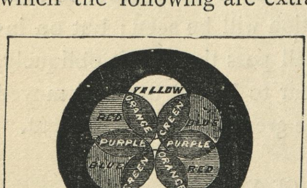


Fig. 90.

directions, the secondary colours will, of course, be seen (Fig. 90). "But great care must be taken, in choosing the blue, to see that it is not of a purple tint, otherwise no approach to a green will be obtained. On attaching two discs to one circle and one to the other, the red being over the blue in the first, we then get all the tertiary colours."

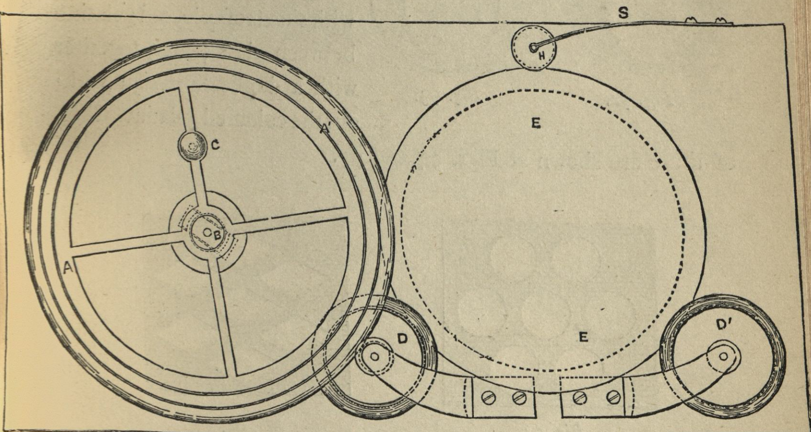


Fig. 91.

An instrument, called the Chromodrome, illustrated at Fig. 91, is arranged for communicating rapid motion to discs of glass, which have various designs attached in coloured gelatine. At Fig. 92 we have a design which will give all the delicate gradations of any colour mixed with white tints in steps, whilst Fig. 93 will give a continual graduated tint. A series of thirty different designs, and a short Manual, by Mr. John Gorham, on the "Rudiments of Colour by Rotation," together with an apparatus for rotating the designs, is supplied by A. N. Myers & Co., 15, Berners Street,

Oxford Street, London. All these may be copied, and exhibited to a large audience by means of the lantern, with great effect.

Another striking way ot showing complementary colours is by means of a set of slides manufactured by the Sciopticon Company, and consist of sheets of perforated zinc, mounted with sheets of coloured gelatine between glass plates, together with a duplicate design without the coloured gelatine. Two of these are shown at Figs. 94 and 95.

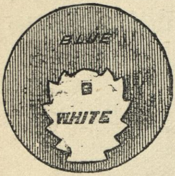


Fig. 92.

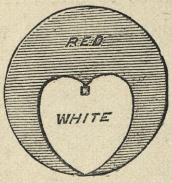


Fig. 93.

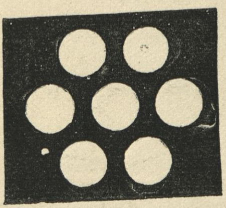


Fig. 94.

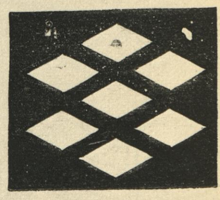


Fig. 95.

CHEMICAL EXPERIMENTS.

Most of the chemical experiments usually shown before classes can be conducted in the lantern with great success, but for this purpose it is necessary that the slide stage shall be open at the top. A tank will be necessary, which may be made of two plates of white glass, kept apart by a strip of India-rubber about half an inch thick, bent round their sides and secured by four screw clamps. Such a tank will hold almost any kind of solution, and is very accessible for cleaning. A neat apparatus, made by Mr. Oakley, can be procured for a small consideration (Fig. 96). A few pipettes will

also be required. These may be made of pieces of glass tube, one end of which should be drawn to a fine point; or a useful pipette,

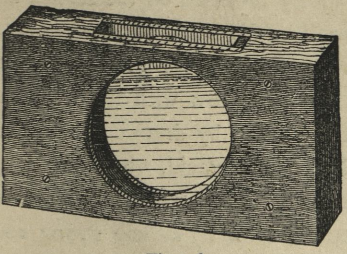


Fig. 96.

shown at Fig. 97, may be obtained, provided with an elastic ball. The experiments which come under the above head are so numerous that only a few will here be given.

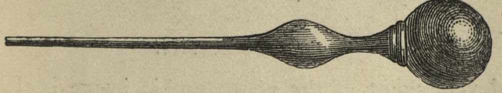


Fig. 97.

Part fill the tank with water, and add a solution of litmus, till the whole becomes of a bluish-purple tint; now by dropping into it from the pipette very dilute acid, a bluish cloudlike effect is produced, and ultimately the whole becomes red. Now, if dilute ammonia be added in like manner, a change is brought about, and the original colour is restored.

Fill the tank with dilute alcohol, and add drop by drop of almost any of the aniline colours (Judson's dyes). The effect resembles a tree shooting out in a variety of ways and branches; and by using different colours at the sides and centre the effect is wonderfully increased.

The Silver Tree is produced by partly filling the tank with a

dilute solution of nitrate of silver. A piece of copper is now bent into the form of an arc, and allowed to dip into the solution. It should now be nicely focussed on the screen, and in a very short time pure silver will be deposited on the copper wire in arborescent form, varying in form in proportion to the strength of the solution.

Precipitation may be shown with the same solution as used in the silver tree experiment, by dropping from the pipette into the solution dilute hydrochloric acid, when very dense clouds of chloride of silver will be produced, which will ultimately subside to the bottom of the tank. Now by adding strong ammonia, the precipitate will be re-dissolved, and the solution become clear.

Crystallization of many substances is well worthy of notice. Thus, if a saturated solution of sulphate of soda be placed in the tank, and a crystal of the same added, the whole will shoot out into a mass of beautiful crystals.

PHOTOGRAPHY.

The development of the photographic image is always a fascinating experiment, and may be performed without much trouble in the following manner: In the first place, the room must be in perfect darkness, with the exception of the light of a candle filtered through a sheet of coloured gelatine or ruby glass. A strip of a glass plate, say 4¼ by 2 inches, or half a quarter-plate cut lengthways, is better for experiment than a larger plate, as, the edges being in view when the picture begins to develop, the effect is better observed. A thin solution of india-rubber in benzol or chloroform should now be applied to the edges of the glass plate; this will dry almost instantaneously. Now coat the glass with a collodion emulsion, better procured ready prepared,—that supplied by the Liverpool Dry Plate Company may be relied upon. As soon as set, it may be dried over a spirit lamp, and is then ready

for printing. One end of the glass plate must now be marked, or if the emulsion be kept a little from one end, this will serve to distinguish it after printing. This precaution is necessary so as to prevent the possibility of developing the picture upside down. It must now be placed in *contact* with a sharp negative, face to face the length way, crossing the negative and the marked end of the prepared plate at the bottom. It may be held in position in an ordinary pressure printing-frame, and exposed to the light of the lantern, or ordinary gaslight. The exposure will vary with the nature of the light and the density of the negative. (See instructions for printing photographic transparencies, page 85.)

So soon as printed and the light lowered, except the non-actinic light above mentioned, it may be taken from the printing-frame. Now flow over its surface a solution of water and alcohol in equal proportions, and after wash the plate in a cup of water. For the *development*, a tank must be used, with a piece of ruby glass inserted between it and the condenser, and upon turning up the light of the lantern, a ruby disc will be projected on to the screen. If the plate be now placed in the tank (the marked end at the top or outside), no image will be visible. A clear solution of pyrogallic acid and water, three grains to one ounce, is now poured into the tank until it is three parts full, and still no change will be apparent; but upon the application of a few drops of a solution of ammonia and bromide of potassium—

Liquid ammonia . .	1 drachm,	mixed in equal proportions,
Water	1 ounce,	
Bromide potassium . .	20 grains,	
Water	1 ounce,	

the image will gradually appear and very soon acquire sufficient intensity, when it must be removed and washed in a cup of clean water. Another tank is next placed in the lantern without the

ruby glass, and nearly filled with a solution of hyposulphate of soda. The plate is now inserted, when it will immediately become clear and more transparent. It should be now removed and washed, and dried over a spirit lamp, when it may be shown as any other transparency.

CAPILLARY ATTRACTION

is shown by a tank, Fig. 96, page 129, placed in the lantern, and half filled with water coloured with a few drops of writing ink, so that it will be more clearly seen. Now, by inserting small glass tubes vertically, the solution will rise inside the tubes in proportion to their diameter. Should a series of glass tubes of different

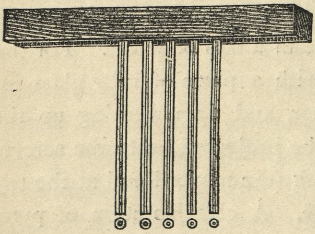


Fig. 98.

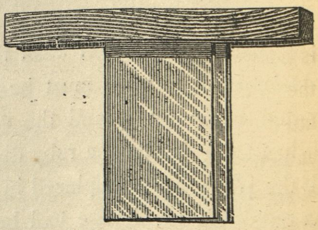


Fig. 99.

diameters, and arranged in a line on a piece of wood, be inserted (see Fig. 98), the different heights will be clearly shown on the screen, proportionately with the fineness of the tubes. A striking illustration may be shown by means of two glass plates attached to a bar of wood, so that two of the edges touch each other, and the other two are some ¼ inch apart (Fig. 99). When these plates are inserted in the tank, the coloured water will rise between the plates where they are in contact, and slope away with a beautiful curve as the plates become more distant.

EBULLITION.

To illustrate that liquids in the spheroidal state and the metal plate are not in contact, accurately level a smooth flat strip of metal about midway across the condensers that it can be removed and replaced easily. It must now be heated by a spirit lamp or other convenient method, and replaced, when a few drops of water may be dropped from a pipette upon the hot plate; the water will now assume the spheroidal state, and by means of a fine platinum wire passed into the globule, the liquid may be kept in position, and upon focussing this accurately on the screen, a space will be distinctly seen between the globule and the hot plate.

ELECTRICITY

is another branch of science which can be illustrated by means of the lantern, and with small, simple, and inexpensive apparatus fitted to the lanterns, many experiments can be exhibited to large audiences, which would be almost impracticable to illustrate in any other way, except at great cost. The apparatus being small, great battery power is seldom required. The bichromate battery offers the best facility to the lecturer: this may be separate, of usual form, or it may be for convenience and portablility fitted to the Sciopticon, as is the one in use by the writer, which was devised and constructed by Mr. W. Watts, of Manchester. It is fitted into the hollow space in the lower portion of the front of the Sciopticon, and consists of two cells 5 inches long by 2½ inches wide. The outside casing is made of zinc plates, forming a box, each pole of the battery terminating in a slight projecting spring, so that when the battery is put into its place these springs press against two brass studs, which project a little inside the Sciopticon base, and being screwed through the base from the outside, have

each soldered on to them, in a vertical position, a split tube similar to a penholder socket. The terminals, which are screwed to the exhibiting tank-frame, being each provided with a brass leg, the tank has only to be pushed down into its place, each leg sliding into its respective socket, and the connections are complete. Should it be desirable to reverse the poles, as in some instances is necessary, this can be done in a moment by simply withdrawing the exhibiting tank from its sockets and reversing its position. As this battery holds only a small quantity of solution, it will not keep up an energetic action so long as the conventional bulbous form of battery, but it possesses for lantern requirements sufficient lasting power, also the feature of compactness and portability, dispensing with wires; which are liable to be pulled out or become entangled in the dark.

The solution cannot be spilt, as the battery is provided with suitable lid and india-rubber pad, also two thumb-screws which effectually tighten all down and prevent any leakage.

The lantern being no more bulky with this attachment than without it, and consequently requiring no extra packing, together with its extreme facility for manipulation, make it a very desirable and useful attachment.

ELECTRO DEPOSITION.

The deposition of one metal upon another by electricity or magnetism—almost invariably the more precious metals being deposited upon the baser—has of late years become so extended as to assume the proportions of a large and lucrative trade, divided into several branches: enormous quantities of nickel and copper, thousands of ounces of silver and gold, besides numerous other metals, are being consumed annually in the various processes of electro deposition. Scarcely a trade exists in which this useful

art is not connected in some way or other, from the massive copper-covered roller of the calico printer, to the most elaborate and costly works of art; and faithful copies of the most antique works of the ancients are being constantly reproduced by those firms who have made this branch of the art their specialty. It cannot, therefore, but be interesting to some of our readers to see and learn something of this important branch of industry, which came into existence about the same period as its sister-art, photography: the one owing its principle of action to light, the other to electricity or magnetism; both illustrating some of the most wonderful of nature's phenomena.

It is in this as in other portions of this work neither our *forte* or intention to attempt an exhaustive treatise upon this subject, our desire being simply to direct the attention of the student by as brief a description as a clear explanation will admit, to a few interesting experiments, projected on the screen, illustrative of electro deposition.

For this purpose a tank and battery will be required: the tank should have two brass terminals, one screwed into each side at the top of the wood frame, to receive the wires from the battery, the most convenient form of which is the bichromate; this should be at least a pint in capacity. Next procure about four grains of fine gold, rolled very thin, about the size of a postage-stamp, also a piece of copper gauze about the same size; this should be flattened a little with a hammer, to close up the texture. Both the gauze and gold plate must now have a piece of thin copper wire, about 4 inches long, soldered to their respective edges; then twist up the free ends into a loop, and screw up tight between the terminals and wood frame. The wires may now be bent down, so as to let the gold plate or anode, and copper gauze or cathode, occupy the centre of the tank without touching each other. Now nearly fill the tank

with water, and drop into it a bit of cyanide of potass, about the size of a horse-bean; whilst it is dissolving, connect up the battery by attaching the wire from the carbon plate to the gold terminal, and the wire from the zinc plate to the copper terminal; lower the zinc plate into the battery solution, and electrolysis will commence immediately. If the anode and cathode or electrodes, as we will now call them, have been adjusted parallel to each other, they can be accurately focussed upon the screen: the image will now appear as a large black square and a trelliswork side by side; and if the battery power be brisk, globules of hydrogen will be evolved from the anode with great rapidity, very shortly the edges of which will become frayed; and as the action goes on a number of perforations will gradually extend from the edges to the centre of the plate; and as it becomes more diaphanous through the continued action, the peculiar texture or crystalline perforations will be more easily observed; and, as the action is still further continued, these perforations will gradually enlarge until small particles of the anode will become detached and fall to the bottom of the tank. Whilst this is going on with the anode, the spaces in the cathode are as gradually becoming filled up; and if the action be allowed to proceed indefinitely, the cathode, or a portion of it, will become so filled up as to almost entirely prevent the transmission of light, whilst the anode will disappear altogether. The liquid in the tank will now have become formed into a double cyanide of gold, but it will only have a small quantity of gold suspended in the solution; because, almost as fast as it can be dissolved from the anode, it will become deposited upon the cathode. This deposit will be of a brownish-yellow colour, it being necessary to raise the temperature of the solution to about 140 degrees to produce the proper gold colour of deposit. This could readily be done by the aid of a spirit lamp, and by observing

a few other chemical conditions; but, as this would not improve the effect of the chemical action upon the screen, we may as well dispense with the extra trouble, our object being solely to utilize or our purpose only those effects which the transmission of light will demonstrate.

Magnetic and diamagnetic phenomena may be demonstrated by use of a small electro magnet, shown attached to a light wood frame at Fig. 100. The magnet should be of soft common iron; with a hole, as shown in the illustration, through which articles to

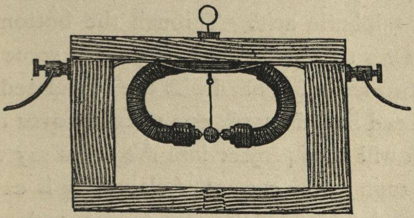


Fig. 100.

be operated upon may be passed. The frame is to be placed in the lantern and the poles of the magnet focussed upon the screen, and with a small battery power some very interesting effects may be illustrated. Fine iron filings, if dropped gently through the hole at the top between the poles, will attach themselves to each pole and give a very curious outline on the screen, increasing in size as the filings are dropped through, until at length they meet together and form the magnetic curve. By fitting into the hole of the frame a cork, through which a brass wire is made to pass, needles and other small articles may be suspended by a silk thread. In the illustration a small disc is shown suspended in the manner described, when a needle or iron disc is suspended between the poles of the magnet; it being attracted by them takes up a position

of rest, joining the poles as illustrated; but a rod or disc of bismuth, on the other hand, would be repelled by the poles of the magnet, and would take up its position of rest at right angles to the poles, thus placing themselves equatorially and illustrating diamagnetism. Pieces of iron, copper, alum, sulphur, paper, charcoal, and small tubes filled with various solutions, such as those of iron, cobalt, water, alcohol, etc., etc., are all suitable for suspending and operating upon.

The electric decomposition of water is effected by sending a current of electricity from three or four cells through water slightly acidulated by sulphuric acid. Through the bottom of the tank two platinum wires should be fixed, projecting some distance into the solution; two test-tubes filled with the acidulated water should now be introduced into the tank, one standing over each platinum terminal, which will thus project into the tubes say three-quarters of an inch: as soon as the current of electricity is caused to pass, from these wires, bubbles will be seen to rise, and soon one test-tube will be filled with hydrogen gas, the other, in which oxygen will be present, will only be half full in the same time.

THE END.

DALZIEL BROTHERS, CAMDEN PRESS, LONDON, N.W.

LIME-LIGHT

W. J. CHADWICK'S

PORTABLE

OXYGEN GAS GENERATOR,

For use with the Magic Lantern, and for General Lime-Light purposes.

Combines **EFFICIENCY, ABSOLUTE SAFETY, SIMPLICITY OF MANAGEMENT,** and **EXTREME PORTABILITY.**

Price, Enamelled inside and Oak Japanned outside, £5 10s.

NO GAS-BAGS, PRESSURE BOARDS, OR WEIGHTS REQUIRED.

The Testimonials received from Professors, Clergymen, Schoolmasters, and numerous Scientific Gentlemen, are *guarantees* of its *superiority* over all other methods.

JOHN CHADWICK,

PRINCE'S BRIDGE IRON WORKS,

MANCHESTER

(NEAR TO ORDSAL LANE RAILWAY STATION).

London—THE SCIOPTICON COMPANY,

157 Gt. Portland Street.

THE SCIOPTICON

was the first of the new Lanterns burning Paraffin Oil, and still holds its place among a host of imitations as unquestionably the best, giving a better light with much less heat, and less consumption of oil than any other.

The principle of the light (patented by WOODBURY AND MARCY) is still the same. The improvements which have since been effected relate to secondary but yet important details.

The flame chamber, originally built into the Lantern, is now made moveable, leaving the whole of the interior free, so that, if desired, the same Lantern can be used for either the Oil, or Lime-Light, Oxy-Hydrogen, Oxy-Calcium, or the Sciopticon Company's new Pyro-Hydrogen Lime-Light—giving a pure WHITE light without oxygen.

No. 1.—THE IMPROVED SCIOPTICON also possesses a special focussing arrangement by which not only is the whole of the light concentrated on the picture, giving 50 per cent. *increased effective light* on the screen, but far better definition is secured. It is, in a word, constructed on SCIENTIFIC OPTICAL PRINCIPLES, and differs in that respect from all other Lanterns.

This form is specially adapted for Photographers for making Enlargements.

4-inch Condensers, selected Double Achromatic Lenses, handsomely fitted on polished wood base, in stained lock-up Case	£6	6	0
Pairs carefully matched and fitted for Dissolving Views ...	13	13	0

No. 2.—A cheaper, but thoroughly effective instrument, same size Condensers, and Lenses in case, £4 4*s*.

No. 3.—THE DRAWING-ROOM 4-inch Condensers, Double Achromatic Lenses, with handsome Silver Lamp which supplies the light, £4 4*s*.

Catalogue of Lanterns and Appliances, one stamp. Sciopticon Manual, with Illustrations and Experiments, 13 *stamps.*

THE SCIOPTICON COMPANY,

157 GT. PORTLAND STREET, LONDON, W.

WOODBURY LANTERN SLIDES.

RIVAL manufacturers—all imitators of the SCIOPTICON—*claim* superiority for their Lanterns; but no one has yet attempted to dispute the immense superiority of the Woodbury Lantern Slides over all others, *particularly since the Sciopticon Company has taken the manufacture of them into their own hands.* The reason is very simple: In the ordinary photographic slide the colouring matter is metallic silver, which is so *opaque*, that the most powerful lime-light often fails to show anything but a heavy black-and-white picture. The Woodbury Lantern Slides are Permanent Pigment Photographs, and the colouring matter is *transparent*, so that all the gradations of shadow are brought out distinctly on the screen with any Lantern.

2s. each; 21s. per dozen. Sample Slide, post-free, 27 stamps.

Inquire of your dealers for Woodbury Slides, or of the Sole Manufacturers—

THE SCIOPTICON COMPANY,
157 GT. PORTLAND STREET, LONDON, W.

THE SCIOPTICON REGISTERING SLIDE-HOLDER

accomplishes easily—what no other will—the accurate registering on the screen of all the different sized Photographic Slides, whether being exhibited in series of the same size, or mixed indiscriminately. *Price* 5*s.*

THE SCENOGRAPH.

The handiest and cheapest Dry Plate Camera made, folding for the pocket, Achromatic Lens and stand, which forms and looks like an ordinary walking-stick.

No. 1. weighs only 1 lb., for Pictures $4\frac{1}{4} \times 3\frac{1}{4}$	... ...	35/	complete.
No. 2, for Stereoscopes, Cabinets, or Two-Lantern Pictures		50/	,,
No. 3, for Pictures 7×5	... ...	50/	,,

The Scenograph Manual, with Instructions and Photograph taken by the Instrument, 7 *stamps.*

THE SCIOPTICON COMPANY,
157 GT. PORTLAND STREET, LONDON, W.

POST OFFICE ORDERS PAYABLE TO GEORGE SMITH.

LANTERN VIEWS
OF THE
ISLE OF MAN.

Standard size, 3¼ inches square.

2s. 6d. each; 24s. per dozen.

WINDOW TRANSPARIENCIES, PAPER PRINTS, &c.

LISTS ON APPLICATION

To **PATTERSON & JAMES,**
"The Studio,"
BALLURE ROAD, RAMSEY, ISLE OF MAN.

In large crown 8vo, price 7*s.* 6*d.*, cloth, gilt edges.

HERALDRY, Ancient and Modern.

INCLUDING "BOUTELL'S HERALDRY."

EDITED AND REVISED BY S. T. AVELING.

CONTAINING NEARLY 500 *ILLUSTRATIONS.*

In crown 8vo, price 1*s.*, picture boards; or cloth gilt, 1*s.* 6*d.*

CARPENTRY AND JOINERY:

A USEFUL MANUAL FOR THE MANY.

WITH ORIGINAL AND PRACTICAL ILLUSTRATIONS.

BY S. T. AVELING.

FREDERICK WARNE AND CO., BEDFORD STREET, STRAND.

YORK'S

MAGIC LANTERN SLIDES

are acknowledged to be the best in the market. They can be purchased through all the leading Opticians and dealers in the

UNITED KINGDOM, FRANCE, GERMANY, ITALY, and AMERICA.

Medals have been awarded at Paris, 1867 and 1878; Philadelphia, 1876; Belgium, 1876; and the Royal Cornwall Exhibition, 1871.

SWAN'S PLATES.

THESE Plates give a new power to the Photographer, enabling him to take Views, Portraits, &c., under conditions of light that would with the wet collodion process have been quite impracticable. Portraits may be taken in ordinary sitting-rooms, without undue protraction of the sitting. Portraits of children can be taken with ease and certainty in a well-lighted glasshouse by means of these Plates. They are suitable for what are called instantaneous views, and they possess many advantages for copying pictures, for interiors, for map copying, and all the work of the Photo-Lithographer; also for enlarging, for copying negatives, and making lantern transparencies. The *cleanliness* and the *simplicity* of the manipulation connected with the use of these Plates, coupled with the certainty and excellence of the result, must bring them into favour with both amateur and professional Photographers.

PRICE OF SWAN'S PLATES,

Manufactured and Sold by MAWSON & SWAN, Newcastle-on-Tyne.

Size of Plates in Inches.	*Per Doz.*	*Size of Plates in Inches.*	*Per Doz.*
$4\frac{1}{4}$ by $3\frac{1}{4}$ or $3\frac{1}{4}$ by $3\frac{1}{4}$, for Lantern Transparencies	3/-	$7\frac{1}{2}$ by 5	8/6
5 ,, 4	4/3	$8\frac{1}{2}$,, $6\frac{1}{2}$	12/-
$6\frac{3}{4}$,, $3\frac{1}{4}$	5/9	9 ,, 7	13/6
$6\frac{1}{2}$,, $4\frac{3}{4}$	6/6	10 ,, 8	18/-
$7\frac{1}{4}$,, $4\frac{1}{2}$	7/6	12 ,, 10	26/6

Special articles for use with very sensitive Plates supplied. Complete Photographic Catalogue, eight stamps.

MANCHESTER.

MAGIC LANTERN SLIDES,

ENGLISH, AMERICAN, and CONTINENTAL,

ON SALE OR HIRE

MAGIC LANTERNS COMPLETE.
MAGIC LANTERN LAMPS.
MAGIC LANTERN CONDENSERS.
MAGIC LANTERN OBJECTIVES.
MAGIC LANTERN GAS-BAGS.
MAGIC LANTERN GAS-HOLDERS.
MAGIC LANTERN GAS-JETS.
MAGIC LANTERN LIMES.
MAGIC LANTERN SLIDE-CARRIERS.
MAGIC LANTERN SCREENS.
MAGIC LANTERN LECTURES.

IN FACT,

Magic Lantern Appliances of every Description

SUPPLIED BY

J. T. CHAPMAN,

Photographic Chemist,

AND

Manufacturer of Special Portable Apparatus for Amateurs.

168 DEANSGATE,

MANCHESTER.

CATALOGUE FREE.

INSKIPP'S RAPID DRY PLATES

(COLLODIO-BROMIDE OF ZINC PROCESS).

Quick, Clean, Reliable, and VERY EASY to develop.

"*I like your plates better than any I have yet tried, either commercial or of my own making.*"—JOHN HOWARTH, Esq., Bradford.

"*Having worked nearly every kind of dry plate that has yet been brought before the public, I write to testify my approval of your plates, which are simply excellent.*" —J. E. ROBSON, Esq., Manchester.

PRICES PER DOZEN.

$4\frac{1}{4} \times 3\frac{1}{4}$, 2s. 6d. | 5×4, 3s. 6d. | $6\frac{1}{2} \times 4\frac{1}{4}$, 5s. 3d. | $6\frac{1}{2} \times 4\frac{3}{4}$, 5s. 6d. | $8\frac{1}{2} \times 6\frac{1}{2}$, 10s. 6d.

H. G. INSKIPP, PHOTOGRAPHER, Tunbridge Wells.

FORREST'S

PATENT PLATE SUBSTITUTE.

PRICES per Gross—$3\frac{1}{4}$ by $3\frac{1}{4}$, **8s.**; $4\frac{1}{4}$ by $3\frac{1}{4}$, **10s.**; 5 by 4, **14s. 9d.**; $6\frac{1}{2}$ by $4\frac{3}{4}$, **24s.**; $7\frac{1}{4}$ by $4\frac{1}{2}$, **25s. 9d.**; $8\frac{1}{2}$ by $6\frac{1}{2}$, **48s.**; 10 by 8, **$9\frac{3}{4}$d.** ft.; 12 by 9, **$10\frac{3}{4}$d.** ft. Not above 1 foot per square, **11d.** per ft.; $1\frac{1}{2}$ foot, **1s.** ft. Usual Terms to the Trade.

J. A. FORREST & SON, 58, Lime Street, Liverpool.

FOCUSSING GLASS, with a NEW AND IMPROVED DEAD MATT SMOOTHED SURFACE, **2s.** per foot.

OPAL PATENT PLATE

Smoothed and Flashed, prepared specially for Carbon Transfers.

NON-ACTINIC GLASS for Operating Rooms, tested by SPECTRUM ANALYSIS, **2s.** ft. net.

In square crown 8vo, price **9s.**, cloth gilt, gilt edges, Fourth Edition, with new Illustrations.

CYCLOPÆDIC SCIENCE SIMPLIFIED.

By Professor PEPPER, of the Polytechnic Institution.

EMBRACING

Magnetism (including the Telephone), Light, Heat, Electricity, Pneumatics, Acoustics, Chemistry.

WITH UPWARDS OF SIX HUNDRED ILLUSTRATIONS.

"A more suitable book for the library of an industrious and intelligent lad we have never seen."—*Mining Journal.*

FREDERICK WARNE & Co., Bedford Street, Strand.

G. W. WILSON & Co.,

PHOTOGRAPHERS to HER MAJESTY in SCOTLAND,

St. SWITHIN STREET, ABERDEEN,

Publish 2,000 MAGIC LANTERN SLIDES, comprising Best Views in Scotland, English Cathedrals and Abbeys, London and Windsor.

PRICES AND CATALOGUES ON APPLICATION.

Lime Cylinders, Oxygen Retorts, Chlorate of Potash,

Magnesium in Ribbon and Powder, Compressed Oxygen Gas, &c.

SCIENTIFIC APPARATUS & PURE CHEMICALS OF EVERY DESCRIPTION.

ILLUSTRATED PRICE LISTS SIX STAMPS.

MOTTERSHEAD AND CO.,

GENERAL LABORATORY FURNISHERS,

7, Exchange Street, and 10, Half-Moon Srteet,

MANCHESTER.

MAGIC LANTERNS,

DISSOLVING VIEW APPARATUS, AND SLIDES.

New Lantern, "The Kalophaneron," burning Paraffin Oil.

The Lantern applied to Educational Purposes.

HOW & Co.'s Series of GEOLOGICAL SLIDES (Photographs), consisting of Groups of Fossils, Sections of Strata, Restorations of Extinct Animals, &c.

Photographs of Microscopic Objects for the Lantern, by Dr. MADDOX.

IN PREPARATION—A Carefully Arranged Series of ANATOMICAL and PHYSIOLOGICAL SLIDES.

CATALOGUE FOUR STAMPS.

JAMES HOW & Co.,

5, St. Bride Street (late 2, Foster Lane),

LONDON.

OPTICIAN BY APPOINTMENT

ICH DIEN

To H.R.H. the Prince of Wales.

J. B. DANCER,

43, CROSS STREET, MANCHESTER,

MANUFACTURER OF

MATHEMATICAL & PHILOSOPHICAL INSTRUMENTS,

The New Patent DUMPY LEVEL. ACHROMATIC MICROSCOPES.

ASTRONOMICAL AND LANDSCAPE TELESCOPES.

THE NEW THREE-POWER FIELD AND OPERA GLASSES.

METEOROLOGICAL INSTRUMENTS.

STANDARD BAROMETERS. ANEROIDS. THERMOMETERS. OZONE TEST PAPERS AND CAGES.

DANCER'S IMPROVED MAGIC LANTERNS, AND NEW DISSOLVING VIEW APPARATUS, with the ECONOMICAL DISSOLVING TAPS.

Oxy-Hydrogen Blowpipes, Gas Bags and Pressure Boards. Lime Cylinders and Cakes.

Paintings and Photo Views for the Lantern in Great Variety.

MICROSCOPE SLIDES WITH ANIMAL, VEGETABLE, AND INSECT PREPARATIONS.

MICRO PHOTOS SUPPLIED TO THE TRADE.

Spectacles, Eye Glasses, and Artificial Human Eyes.

PRIZE MEDAL, 1862.

W. H. OAKLEY & CO.,

PHILOSOPHICAL & OPTICAL INSTRUMENT MANUFACTURERS.

Magic Lanterns, Improved Dissolving View Apparatus, Photographed and Painted Slides, Compressed Oxygen and Hydrogen Gas, Slide Frames and Boxes, and Improved Dissolving View Taps, Jets, &c. Panoramic Slide Holders, &c.

202, GRANGE ROAD, BERMONDSEY, LONDON, S.E.

WINTER EVENING LECTURES.

The Combined Biunial Lantern, the most powerful and compact Lantern made. SPECIALTIES — Improved Dissolving Tap, Canting and Revolving Table, simplified Jets, Lengthening Tubes, adjusting Fronts. Improved Packing and Manipulating Case, combined and mounted on No. 3 Stand. Prices from £10 to £50.

Oakley's Improved Dissolving Tap, 21s.

Oakley's Improved Revolving and Canting Table (made to suit any Lantern, Box, or Stand, 15s. to 30s.

Magic Lanterns, Dissolving Views, Slides, Screens, Oil, Gas in Iron Bottles, Musical Boxes, Microscopes, Electric Machines, &c. &c., for Sale or Hire. Lists and Terms upon application.

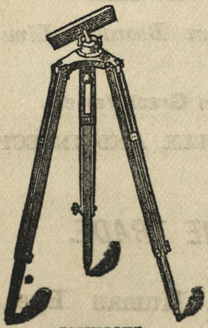
3-inch Slides—Plain, 18s. per doz.; Coloured, 36s. and 48s. per doz.; Comic, Lever, Mechanical, and Rackwork **Slides** Lent on Hire at 2s. 6d. per doz. Schools and Private Parties attended. Stereoscopic Views 10s. per doz.

Lectures and Services of Songs, Lecture Books, &c.—Fairy, Comic, and Temperance Tales, &c., or any subject required.

Improved Reading Desk throwing Light on Book only.

		£	s.	d.
OAKLEY'S Improved Animalcule or Chemical Tank for Experiments in the Lantern. Is not affected by any Chemical	each	0	4	0
India-rubber Pipette for blowing or moving Liquids or Animals	each	0	1	6
Slide for showing Capillary Attraction, with the above Tank	(Plates)	0	2	0
Do. do. do.	(Tubes)	0	2	0
Slide for Showing Electro-Magnetic, Magnetic, and Dia-Magnetic Experiments	...	0	13	0
Acid Battery, suitable for working do.	...	0	6	0

Improved Screen Elevators, Double Pressure Boards, &c.



COPYRIGHT.

THE A 1 UNIVERSAL TRIPOD STAND (Oakley's Improved) is a firm and adjustable STAND for Photographers, Exhibitors, Opticians, Surveyors, &c. It will adjust from the smallest possible adjustment or angle, and is made in various sizes, suitable for all purposes, and as rigid when at the total height as when down. Invaluable for taking Interiors on Stone Pavements, and can be set level upon the side of a hill, roof of house, &c. &c. Also the Ball and Socket is fitted, also Revolving Table, if required, and has many advantages. (See Testimonials.) For further descriptions see Price Lists—Free upon application.

Photograph Trimmer. SHAPES. **Glass Cutter** (nearly equal to diamond.)

Oakley's Improved Plate Draining Racks, unaffected by any chemicals (may be stood in acids). Valuable to every Photographer. Many fine Photographs are spoiled by racks containing chemicals that have dried into the grooves. See List with further descriptions. Improved Plate Boxes with grooving not affected by chemicals. Printing Frames, Storing Boxes, &c. Grooving of all kinds. Having Machinery for all kinds of Wood, Iron, and Brass Work (heavy or light), we are prepared to make any kind of Instrument or Apparatus to Instructions or Drawings.

Oakley's Self-acting Plate Cleaning Desk.

SEE ILLUSTRATED PRICE LIST.

List of Improvements in Photographic Appliances Free.

MAGIC LANTERNS & MICROSCOPES.

IMPORTANT IMPROVEMENTS. PRICES GREATLY REDUCED.

Our Celebrated Lantern for use of Schools, Band of Hope Meetings, &c., gives a brilliant 10-feet Disc, has 3·⅜ Double Condensers, Argand or Silber Light, Price only £1 1*s.* Mechanical Slides, Hymns, &c., 1*s.* LIME LIGHT Apparatus, complete, giving a 20-feet Bright Disc with any Lantern, for £2.

W. F. ARCHER, Manufacturer, 60, South Castle Street, LIVERPOOL.

N.B.—SEND FOR PRICE LIST. MANY SPECIALTIES.

TRADE-MARK REGISTERED

NEW AND SECOND-HAND
LENSES, CAMERAS & APPARATUS,

By ROSS, DALLMEYER, and all the finest makers.

ILLUSTRATED CATALOGUE TWO STAMPS.

W. MORLEY, 70, Upper Street, London, N. (*Est.* 50 *Years.*)

MAGIC LANTERN SLIDES

PRODUCED BY

J. VALENTINE,

PHOTOGRAPHER BY APPOINTMENT TO THE QUEEN.

Series of 24 Slides of Clouds, Water, and Shipping, from Instantaneous Plates.

May be had from Dealers or direct from J. VALENTINE, DUNDEE, N.B.

CATALOGUES of over 3000 SUBJECTS on Application.

DISSOLVING VIEW APPARATUS AND SLIDES.

(AS USED AT THE POLYTECHNIC.)

Before purchasing, see Hughes' Patent Bicylindrical Limelight Apparatus. A Set, £6 6s.

PATENT TRIPLEXICON LANTERN.

Gives the most brilliant light of any. Sir Antonio Brady, Dr. Croft, and J. H. Varley, Esq., compare it to the Limelight. A combination of three wicks! Illuminating power, 110 candles. We challenge publicly a Trial. Price £4 4*s.*, with 4-inch Condensers. Triplexicon Pamphlets, 1*d.* The Educational Duplexicon Lantern, £2. 20,000 Slides to select from—every subject. Scripture Lectures, Life of Wesley, &c., Hymns, &c., plain, 1*s.*, coloured, 2*s.* Great Novelties, New and Startling Effects. Paris and Exhibition, Cyprus, Cleopatra's Needle, China, &c., &c. Illustrated Catalogue, with testimonials and opinions of the press, 140 pages, 6d. Cheapest and best in England.

W. C. HUGHES, Optician, 151, HOXTON STREET, N., LONDON.

EXPERIMENTS ON A LUMP OF CAMPHOR.

By C. TOMLINSON, F.R.S.

Cabinet of Apparatus for performing a number of pretty and interesting experiments accompanied by a book fully explaining them. 12s.

A. N. MYERS & CO.,

15, BERNERS STREET, OXFORD STREET, LONDON, W.

Publishers of the Kindergarten Appliances.

Catalogue of Educational Toys, Games, &c. may be had on application.

MAGIC LANTERN SLIDES.

LARGEST AND BEST STOCK OF MAGIC LANTERNS AND SLIDES IN THE KINGDOM.

FOR SALE OR HIRE.

CATALOGUES POST FREE ON RECEIPT OF ONE STAMP.

E. G. WOOD, Optician, 74, Cheapside, London.

The "Euphaneron" Lantern, with Patent Refulgent Lamp, is unsurpassed for Power, Portability, and Price, £4 4s.

MAGIC LANTERNS: How Made and How Used. Second Edition. With Practical Hints to Unpractised Lecturers. By A. A. WOOD. 1s. post free.

MUSEUM OF SCIENCE.

ARTISTS TO THE ROYAL POLYTECHNIC.

KNOTT & CO.,

DISSOLVING VIEW APPARATUS, AND EVERY DESCRIPTION OF SLIDE MANUFACTURERS.

22, ELLIOT STREET, LIVERPOOL.

Artists to all the Leading Institutions, Public Lecturers, &c.

ESTABLISHED 38 YEARS.

THOUSANDS OF GENUINE TESTIMONIALS.

Slides from Negatives sent, and every Description of FIRST-CLASS WORK ONLY.

The Finest Slides in the World are produced at this Establishment, at very Moderate Prices.

KNOTT'S Apparatus is not equalled anywhere for Portability, Fine Definition, and Simplicity. There are no others to be compared.

SEND FOR CATALOGUES. POST FREE.